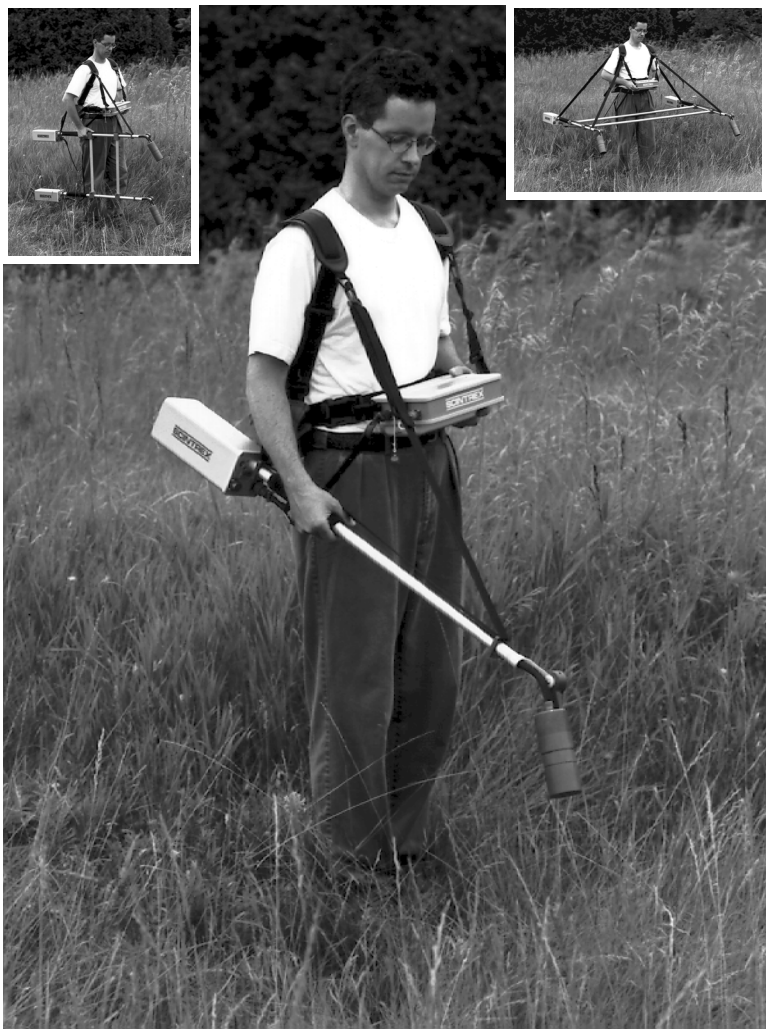
SCINTREX

SMARTMAG
MODELS SM—4/4G

OPERATIONS MANUAL



SCINTREX LIMITED

Head Office

222 Snidercroft Road
Concord, Ontario
Canada, L4K 1B5

Tel.: (905) 669-2280
Fax: (905) 669-6403 (Sales)
(905) 669-9899 (Service)
Telex: 06-964570

In the U.S.A.

525 Fort Worth Drive
Suite 216
Denton, Texas 76201

Tel.: (817) 591-7755
Fax: (817) 591-1968

In Australia

1031 Wellington St.
West Perth,
West Australia 6005

Tel: (619) 321-6934
Fax: (619) 481-1201

Copyright © SCINTREX Limited 1996. All rights reserved.

No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form, or by any means, electronic, mechanical, photo-copying, recording, or otherwise, without prior consent from SCINTREX Limited.

SMARTMAG and WALKMAG are trademarks of SCINTREX Limited.

Document P/N 759 704
Revision 1.0

Manual designed and produced by ***GEO F/X***.

Printed and bound in Canada.

Table of Contents

Disclaimer

Preface

Features xi
SMARTMAG versions. xii
About This Manual. xv
Type styles xv
Page numbering xv
Symbols. xvi
HELP-Line xvii

1—Introduction

Cold boot 1–2
Instrument overview 1–3

2—Preparing the SMARTMAG

Unpacking 2–2
Repacking 2–2
Assembly. 2–3
Installing the battery belt 2–3
Installing/exchanging the battery in the battery belt. 2–4
Connecting the sensor(s) to the Battery Belt 2–4
Installing the LED display and keyboard 2–5
Installing the shoulder strap 2–6
Installing the audio option kit 2–6
SMARTMAG console battery installation/exchange 2–7
Using the external battery pack 2–8
Using an external power supply 2–10

3—Guidelines

Operator preparation 3–1
Geometry of dead zones 3–1
Determining operating zones 3–3
Adjusting the sensor head angle. 3–4

4—The SMARTMAG Model SM—4

Receiving your instrument 4–1
The components 4–2
    Assembling the instrument 4–2
    Connecting the cables. 4–2
Setting up the instrument 4–3
    Turning on the instrument 4–3
    Using the headphones. 4–4
Setting the parameters with the console 4–4
Using the LED display and keypad. 4–5
    Keypad 4–5
    Displays and Functions 4–5
Performing a Survey 4–8

5—The SMARTMAG Model SM—4G

Receiving your instrument 5–1
The components 5–2
Assembling the instrument 5–2
    Master processor 5–2
    Connecting the cables. 5–3
Setting up the instrument 5–4
    Turning on the instrument 5–4
    Using the headphones. 5–4
Setting the parameters with the SMARTMAG console . . . 5–5
Using the LED display and keypad. 5–5
    Keypad 5–6
    Displays and Functions 5–6
    Assembling the Gradiometer 5–9
        Vertical Gradiometer 5–9
        Horizontal Gradiometer 5–10
Performing a Survey 5–10

6—The SMARTMAG Console

Pre-defined operating modes 6–1
Console description 6–3
Keypad description 6–4
Key Functions 6–5
Display screens 6–8
General information 6–8
Cursor 6–9
Display blocks 6–9
Pop-up windows 6–10
Help screens 6–11
Operating displays 6–12
Basic mode configuration displays 6–12
Basic mode data collection displays 6–16
Search mode configuration display 6–17
Search mode data collection displays 6–19
Advanced mode configuration displays 6–20
Main operating display 6–20
Instrument setup display 6–22
Magnetometer setup display 6–23
Advanced mode data displays 6–26
Numeric data display 6–26
Graphic data display 6–28
Recall displays 6–29
Recall setup display 6–29
Recall data display 6–30
Modifying the display window 6–32
Auxiliary display 6–33
Data output display 6–34
Data output formats 6–36
Notes display 6–37
Information display 6–38
SMARTMAG Distance Trigger 6–39

7—Setting-up the SMARTMAG Console

First time operation 7–1
Cold Boot 7–2
Configuration menu 7–3
General setup principles 7–4

How to: 7–5
Access the main operating display 7–5
Access display sub-panels/blocks 7–5
Access the parameter fields 7–5
Change parameters 7–5
Select! and Enter!. 7–6
Select! 7–6
Enter! 7–6
Line and Station setup 7–7
Entering the starting station 7–8
Entering the starting line 7–8
Basic Mode 7–9
Sample total-field setup 7–9
Starting Your Survey 7–11
Search Mode. 7–12
Sample search mode setup 7–12
Advanced Mode 7–14
Instrument setup 7–14
Sample total-field setup (WALKMAG or WALKGRAD) 7–15
Sample base-station setup 7–18
Information display 7–21
Note entry. 7–23
Display intensity control 7–25
Parameter lock. 7–26
Reprogramming the operating system 7–27
At the computer 7–27
At the SMARTMAG Console 7–27

8—Operating the SMARTMAG with the Console

Accurate and meaningful measurements 8–1
Determining operating zones 8–2
Effects of gradient 8–2
Other sources of noise 8–2
Base-station 8–3
Repeated surveys lines 8–3
WALKMAG—Total-field/Gradiometer 8–4
Check your setup 8–5
Start survey 8–5
WALKGRAD gradiometer survey 8–6

Manual mode—Total-field/Gradiometer 8–7
Check your setup 8–8
Start survey. 8–8
Automating your measurements 8–9
Base-station operation 8–10
Check your setup 8–11
Start operation 8–11
Search mode 8–12
Basic 8–12
Advanced 8–13
Survey data correction procedures. 8–14
Using base-station data 8–14
Tie-point (TIE-PT) mode 8–15
Loop type—collecting data 8–15
Line type—collecting data. 8–16
Tie-point correction procedure 8–18
Basic modes (Loop only) 8–18
Advanced modes 8–19

9—Data output

Output formats 9–1
XYZ 9–2
XYZ+ 9–3
XYZ++ 9–4
PRN. 9–5
NOTES 9–6
BINARY 9–7
Converting binary data with XFSMART 9–7
Basic mode 9–9
Advanced mode 9–10
Output setup 9–10
Dumping data 9–12
All data 9–12
Specific data 9–13
Binary Dump 9–13
Line by line. 9–14
Erasing data from memory. 9–15
Basic mode 9–15
Advanced mode 9–16

10—Maintaining your SM—4/4G

General rules. 10–1
Charging the battery belt batteries 10–2
Console battery charging 10–3
One battery 10–4
Two batteries 10–5
Periodic maintenance 10–6
Desiccant exchange 10–6
Fuse replacement 10–7
Console disassembly/assembly 10–8
Cable repair. 10–9
Sensor troubleshooting guide 10–10
Console troubleshooting guide 10–11

11—Reference information

SMARTMAG Technical Specifications 11–1
Options 11–3
Instrument parts list 11–4
Warranty & Repair 11–5
Warranty 11–5
Repair 11–5
When to ship the unit 11–5
Description of the problem 11–5
Shipping instructions 11–6
Customs documents 11–7

A—Orienting Cesium sensors for best performance

Introduction A–1
The active zone of the SMARTMAG. A–2
Calculation of the tumble angle. A–5
Recommended sensor orientations. A–14

DISCLAIMER

The product supplied by the vendor under this sale agreement, when properly maintained, calibrated and operated will perform in accordance with the vendor's published specifications. The vendor disclaims responsibility for the detection of any particular target under any particular set of circumstances, and the purchaser and or user hereby acknowledges and accepts such a disclaimer.

The purchase and or user releases and agrees to hold harmless the vendor, its officers, servants, employees, agents and contractors, against any and all claims, demands, actions and liabilities whatsoever, arising out of the use or operation of the product.

It is understood and agreed that this contract shall be governed by the laws of the Province of Ontario, Canada.

Disclaimer

PREFACE

Congratulations on purchasing the SMARTMAG high sensitivity, high resolution, cesium vapour magnetometer/gradiometer from SCINTREX Ltd.! You are in possession of one of the most advanced magnetometers for environmental, geotechnical, archaeological and mineral exploration uses of today.

The SMARTMAG is a portable, cesium magnetometer that also is inexpensive, lightweight and rugged. In its trademarked *WALKMAG* mode, it is ideal for applications where high production, fast reading and high sensitivity are required.

Your SM–4 is quite versatile and can be optionally upgraded and configured as a gradiometer or as a base-station. To upgrade your system to the SM–4G model, please contact your SCINTREX representative.

FEATURES

SMARTMAG

The main features/options of the SMARTMAG include:

- integrated sensor/staff and processing electronics
- advanced digital signal processing for low noise 0.01nT resolution
- rugged, waterproof design incorporating adjustable sensor head
- audio output with auto baseline tracking
- sunlight readable LED display and keypad
- RS-232/RS-422 output
- SMARTMAG console

Console

The main features of the SMARTMAG *console* include:

- real-time graphic display of magnetic field readings
- interactive menus for easy operator use
- selectable sampling rates as fast as 10 times per second
- WALKMAG mode for rapid data acquisition
- true simultaneous gradiometer option with the WALKGRAD mode for rapid data acquisition
- large internal memory, expandable to over 300,000 readings (750,000 for base station)
- easy to read, large LCD screen that displays data both graphically and numerically
- easy review of the data and *Datacheck* quality control
- ENVIMAP software for processing and mapping of the data

SMARTMAG VERSIONS

There are five versions (factory configured) of the SMARTMAG:

1. SMARTMAG model SM-1 (759 001):

Figure A SMARTMAG model SM-1 components

2. SMARTMAG model SM-2 (759 005):

Figure B SMARTMAG model SM-2 components

3. SMARTMAG model SM-3 (759 002):

Figure C SMARTMAG model SM-3 components

4. SMARTMAG model SM-4 (759 003):

Figure D SMARTMAG model SM-4 components

5. SMARTMAG model SM-4G (759 004):

Figure E SMARTMAG model SM-4G components

ABOUT THIS MANUAL

TYPE STYLES

The following typeface conventions will be used throughout the manual. There may be additional conventions used in the specific sections. These will be described in the introduction for the section.

Convention	Use
Bold	An action you are required to perform A proper name.
Italic	A new term is being introduced An item of importance is being emphasized.
Dot Matrix	A prompt on the SMARTMAG console Text to be input to the console.
LED	A prompt or parameter on the LED display.
ALL CAPS	A display or key on the SMARTMAG console The name of a method, item or mode.

PAGE NUMBERING

The page numbering scheme used consists of two parts; the *chapter number* and *page number.* For example, **3-1** would refer to Chapter **3**, page **1**.

For your convenience, each chapter in a section has a thumb-tab on the right-hand side allowing you to quickly locate a chapter of interest. The thumb-tabs are arranged in descending order.

SYMBOLS

The following symbols will be used to highlight specific sections of text throughout the manual.

Symbol	Meaning
▲	Indicates an item in a list/grouping or a single-step procedure
	Note: Indicates specific information that you should read.
	Hint: Indicates a tip, new idea or helpful hint.
	Caution: Indicates a note of caution. You should pay special attention to this section.
	Warning: Indicates a warning. You should read this section very carefully.
	Important: Please read this! Indicates a very important message.

HELP-LINE

In order to provide a high-degree and quality of technical support, a special HELP-Line is available for SMARTMAG users. If you need any help with the instrument, applying the instrument to a particular problem or help with the ENVIMAP software, please contact SCINTREX support at the following numbers:

In Canada:

Telephone: **(905) 669-2280**
Fax: **(905) 669-6403 (Sales Department)**
(905) 669-9899 (Customer Service)
Telex: **06-964570**

In the U.S.A.:

Telephone: **(817) 591-7755**
Fax: **(817) 591-1968**

In Australia:

Telephone: **(619) 321-6934**
Fax: **(619) 481-1201**

Chapter 1

INTRODUCTION

This manual is divided into twelve chapters with the information flow from chapter to chapter following a natural progression, as shown in the following table:

Chapter	Description
Introduction	Outlines what the instrument can do.
Preparation	Describes the assembly of the system in preparation for use.
Guidelines	Provides guidelines, hints and basic trouble-shooting information that are common to all SMARTMAG models.
SM—4 Model	Provides step by step instructions on how to use the SM–4 SMARTMAG without the console.
SM—4G Model	Provides step by step instructions on using the SM–4G SMARTMAG without the console.
Console	Describes the physical parts of the SMARTMAG console, keypad and display menus. It also describes the function of each key, as well as the various modes and parameters shown on the display panel.
Setting up	Gives step-by-step instructions on how to set up the instrument as either a total-field magnetometer, a gradiometer or a magnetic base-station.

Chapter	Description
Operations	Guides you through typical instrument operation, using basic and advanced configurations, in a WALKMAG and a stop-and-go type of survey.
Data Output	Shows examples of data output formats and explains how to dump the acquired data to a computer.
Maintenance	Describes basic maintenance, trouble-shooting and repair.
Reference	Contains the technical specifications, instrument parts list and warranty information.
Appendix	Gives a detailed overview of issues relating to optimum sensor orientation.

COLD BOOT

Note: *Please* read the section "First time operation" on page 7–1 so that you will know how to do a *cold boot* of the instrument. This is needed the first time you use it, whenever you wish to change operating configurations, or after the batteries have been removed for more than 10 minutes.

INSTRUMENT OVERVIEW

The SCINTREX SMARTMAG is an easy-to-use, light-weight, battery-powered, portable magnetometer. It is a total-field instrument using the Larmor frequency of precession of cesium atoms to measure the local magnetic field. Optional upgrade kits allow the instrument to be used as a gradiometer or as a base-station.

Measured data is stored in memory along with the coordinates where the measurement took place. In the advanced configuration modes, you can also enter descriptive notes of up to 32 characters at any station. The data can be displayed either numerically or graphically for quick inspection of the data quality and spotting of anomalies. Data can also be recalled from memory for visual inspection, dumped to the serial port (RS-232) of a computer or directly to a printer. You can also automatically correct your magnetic data for diurnal variations when another SMARTMAG is used as a base-station or when you conduct your survey in the TIE mode.

To make the SMARTMAG easy to use, there are preset configurations for site characterization, drum location, archaeology, general search, ground water, mineral, oil and gas exploration. These configurations fall into two categories: *basic* (where you only need to set a few parameters) and *advanced* (where you have complete control over all operating modes).

The operating modes of the SMARTMAG can be manual, semi-automatic or fully automatic. In the WALKMAG (*walk*ing *mag*netometer) mode, data are acquired and recorded at rates of up to ten readings per second, as you walk at a steady pace along the survey line. At desired intervals, you *trigger* a station marker by pressing a single button and the co-ordinates are automatically assigned to the recorded data.

Note that each model of the SMARTMAG (SM–1 through SM–4G) may require additional software and/or hardware to be converted from one model to another, if desired. Please consult your sales representative for further information.

Chapter 2

PREPARING THE SMARTMAG

This chapter describes:

- how the SMARTMAG is packaged,
- how to connect the components to get an operational unit,
- the various options you may have for powering the unit.

The following two photographs show all the components (less packing materials) of the standard SMARTMAG and the SMARTMAG Gradiometer.

Figure 1 The complete SMARTMAG SM–4 kit with optional accessories.

Figure 2 The complete SMARTMAG gradiometer kit with optional accessories.

UNPACKING

The standard SMARTMAG is shipped in a durable carrying/shipping case that should be retained for storage and shipping. This provides a proper place for every item when you repack your instrument for shipping or storage. Please check the components delivered against the actual order, as systems may vary

REPACKING

Please make certain that the *batteries* are *removed* and stored in the appropriate places. Failing to do so may result in damaged batteries and possibly a damaged console.

Warning: The batteries must be *removed* from the unit prior to shipping or storage.

FAILURE TO DO SO MAY RESULT IN DAMAGE.

ASSEMBLY

In order to make the system as compact as possible for shipment and storage, and considering the various sensor configurations available, the SMARTMAG system requires you to connect up the external components. This section will describe the steps required to completely assemble your instrument.

INSTALLING THE BATTERY BELT

The battery belt contains the batteries that power up the SMARTMAG sensor assembly. The SMARTMAG console is powered by batteries that are stored within the console housing and is discussed in “SMARTMAG console battery installation/exchange” on page 2–8.

Figure 3 The Battery Belt

INSTALLING/EXCHANGING THE BATTERY IN THE BATTERY BELT

1. When installing replacement batteries, disconnect the existing batteries and install the new ones.
2. Adjust the battery pouch velcro compartments to secure the batteries in the pouch.

CONNECTING THE SENSOR(S) TO THE BATTERY BELT

1. Using the following diagram, connect the appropriate assemblies to the connectors on the Battery Belt box which is located on the underside of the Battery Belt.

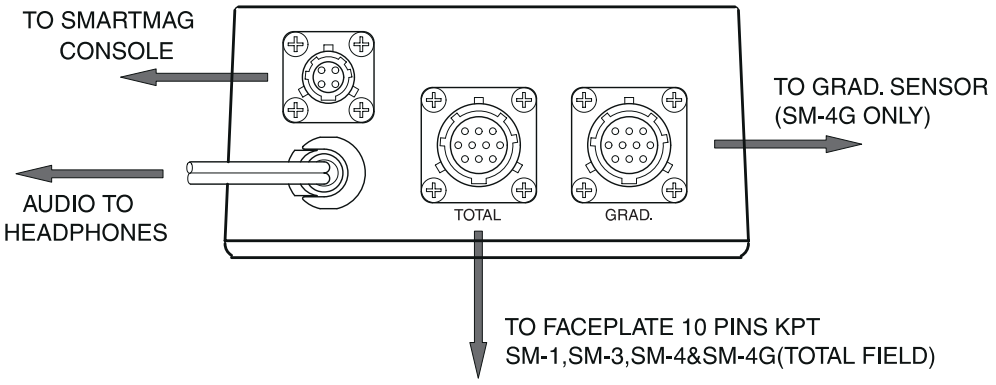


Figure 4 Battery Belt Box Connectors

INSTALLING THE LED DISPLAY AND KEYBOARD

1. Attach the mounting brackets to the sensor staff by using the four, #4 Philips screws that are supplied with the mounting kit as shown below. Ensure that the mounting bracket with the velcro is mounted on the top of the staff.

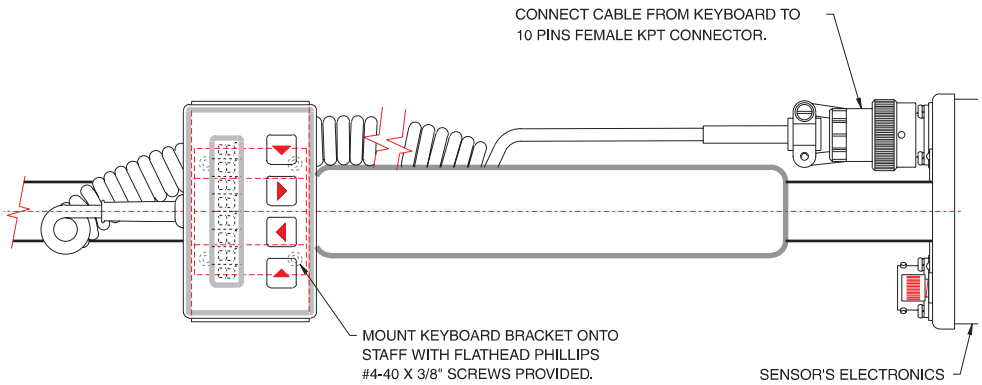

CONNECT CABLE FROM KEYBOARD TO
10 PINS FEMALE KPT CONNECTOR.
MOUNT KEYBOARD BRACKET ONTO
STAFF WITH FLATHEAD PHILLIPS
#4-40 X 3/8" SCREWS PROVIDED.
SENSOR'S ELECTRONICS

Figure 5 LED and Keyboard Mounting Kit

2. Attach the display and keyboard to the top of the mounting bracket with the velcro.
3. Connect the display and keypad connector to the rear of the sensor compartment as shown in the diagram.

INSTALLING THE SHOULDER STRAP

1. Thread the shoulder strap through the plastic clips and attach the strap to the sensor staff as shown in the diagram below:

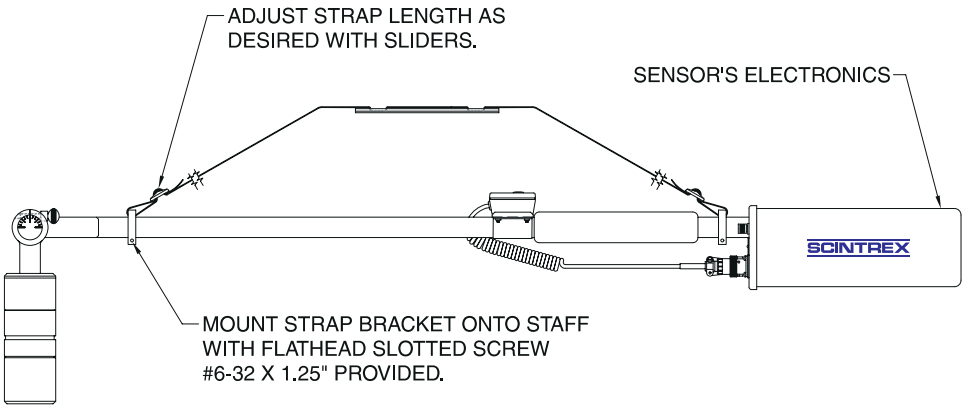


Figure 6 Installing the shoulder strap

2. Adjust the straps in the plastic clips until the sensor staff is the correct height and the strap comfortably fits your shoulder.

INSTALLING THE AUDIO OPTION KIT

The Audio option can be added to the SMARTMAG after you have taken possession of the instrument by adding the audio option kit. To install the audio option in your SMARTMAG, please contact the factory.

SMARTMAG CONSOLE BATTERY INSTALLATION/EXCHANGE

The SMARTMAG console is shipped *without* the battery installed. This is the proper procedure, while shipping and storing the instrument, to prevent *deep discharge* of the battery. Deep discharge can possibly cause permanent damage to the battery and will always shorten the battery life. This situation will occur because a small current is being drawn even if the instrument is turned *off*.

The following steps outline the battery installation:

1. **Turn** the instrument face down on a clean and even surface.
2. **Unscrew** both knurled screws on either side of the battery cover and lift the cover off.
3. **Place** the battery into the recess in the rear panel of the instrument.
4. **Connect** it carefully to the MAIN BATTERY connector. It is not important which side of the plug is up, as long as the connector pins are properly aligned.
5. **Replace** the cover and tighten both knurled screws.
6. If this is the first time installation, proceed with battery charging.

The small size and low cost of the battery makes it convenient to carry an additional battery along as a spare.

Warning: An internal battery keeps the memory and the internal clock alive for about **10 minutes.** It is strongly advised that the switching to the spare battery be done **quickly, TO PREVENT THE LOSS OF YOUR DATA!**

You need not worry about a low battery causing data loss, since the memory power requirements are much less than those needed to make a valid reading of the magnetic field.

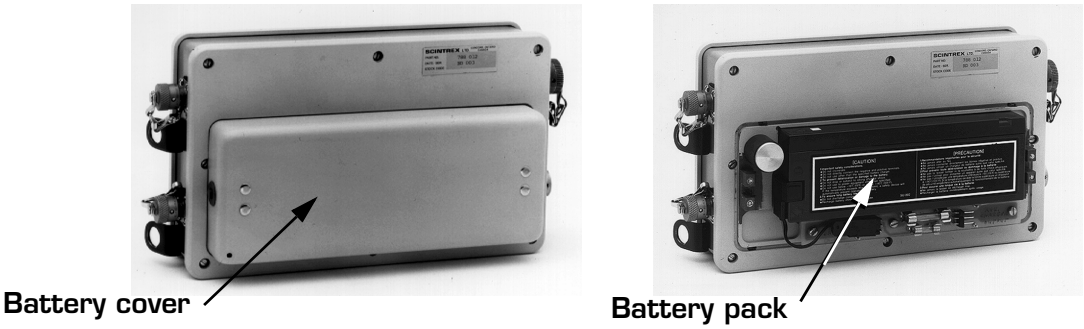


Figure 7 SMARTMAG battery pack

USING THE EXTERNAL BATTERY PACK

The standard battery should provide 24 hours operation at 20°C and 8 hours of operation at -40°C. Extended cold weather WALKMAG surveys may require more power than the standard battery together with a spare can provide. To satisfy this additional requirement, the *External Heavy Duty Battery Pack* (SCINTREX part number 788 026) is available. It provides about *three* times as much power as the standard battery. This battery pack can be carried by the strap or attached to a belt.

To connect the external battery you must proceed as follows:

1. **Turn** the instrument face *down* on a clean and even surface.
2. **Unscrew** both knurled screws on either side of the battery cover.
3. **Lift off** the cover and *store* it somewhere convenient for future use with the standard battery configuration.
4. **Remove** the standard battery.
5. **Connect** the connector in the dummy battery cover carefully to the MAIN BATTERY connector. It is not important which side of the plug is up, as long as the connector pins are properly aligned.

6. **Place** the *new* cover on to the console by gently pushing it into its place and **tighten** the knurled screws on both sides.
7. Please check the battery voltage condition at this stage and charge the battery, if it is required.

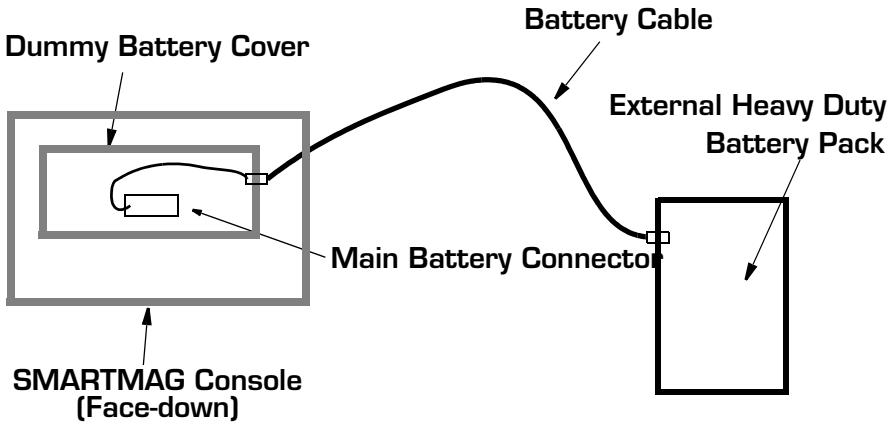


Figure 8 External heavy duty battery connection

USING AN EXTERNAL POWER SUPPLY

More demanding applications, such as an extended base-station operation, may require more power than can be provided with the either of the SCINTREX supplied battery packs. In this case you have two options:

a) AC-power

If a source of AC-power is available, the instrument can be run while the charger is connected to it. You will also be charging the standard internal battery, if it is installed, at the same time.

Note: Please be aware of possible magnetic noise from generators, and ensure that all cabling and sensors are as far away as possible from the generator as possible.

b) 12-volt battery (car or marine)

A 12-volt car battery may be more appropriate for other applications. The special *External Power Cable* (SCINTREX P/N 788 029) should be used for this purpose.

1. The standard internal battery may be left in place.
2. **Plug in** the end of the cable with the single plug into the Charger Connector at the right-rear side of the SMARTMAG console. (See item 6 in Figure 12 on page 6–2.)
3. **Connect** the end with the clips to the battery terminals. The *red* cable-clip goes to the *positive* battery terminal. The *black* cable-clip goes to the *negative* battery terminal.

Caution: The correct polarity must be used for the instrument to operate properly.

GUIDELINES

OPERATOR PREPARATION

Prior to conducting a search or survey with a cesium magnetometer, the operator must remove all offending metallic items from his/her body (some metals are non-magnetic or have low magnetic signature; aluminum and brass for example). Commonly worn or carried magnetic items include the following: belt buckles, watches, coins, steel toed boots/shoes, metal buttons, pocket knives, compasses and magnets. It may not always be obvious that an item contains metallic parts, for example some shoes may have metallic eyelets. Of course, the SMARTMAG can be used to test suspect items.

GEOMETRY OF DEAD ZONES

Cesium magnetometers will operate properly only if the angle that the sensor head makes with the earth's magnetic field vector is within the ranges 10–85 degrees, 95–170 degrees, 190–265 degrees and 275–355 degrees. When the sensor head is parallel (more correctly in line, which consists of parallel and antiparallel alignment) or at right angles to the earth's magnetic field vector, no usable signal is available. For a small zone about parallel and right angle alignment there is still no usable signal. These zones are referred to as *dead zones* and are illustrated in Figure 9 on page 3–2.

For parallel alignment we have two dead zones, the first about 0 degrees with range –10 to +10 degrees and the second about 180 degrees with range 170–190 degrees. These two zones are referred to as the *polar dead zones* and form two conical solid angles in three-dimensional space.

For right angle alignment, we have a dead zone whenever the sensor head is in the plane perpendicular to the earth's magnetic field vector. This zone is encountered whenever the angle that the sensor head makes with the earth's magnetic field vector is in the range of 85–95 (or 265–275) degrees. This zone may be considered as a disk in three-dimensional space, and is referred to as the *equatorial dead zone*.

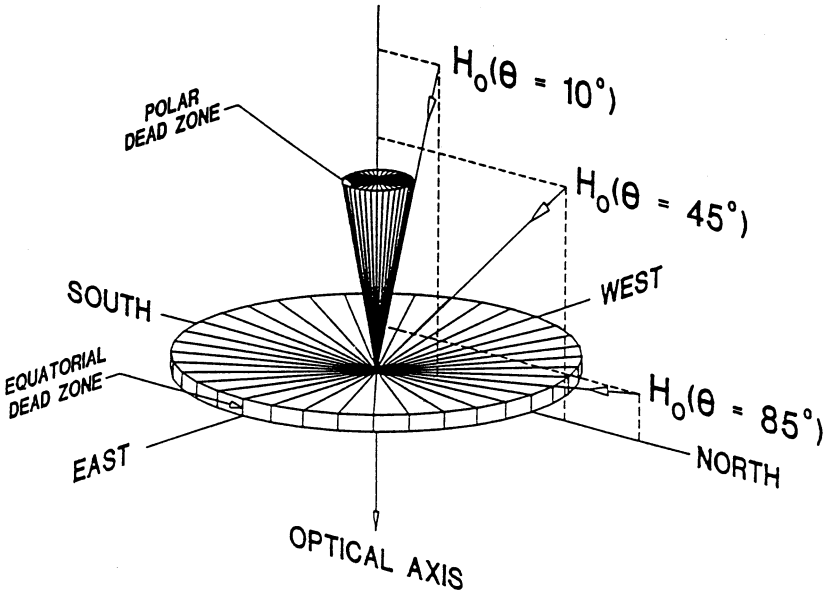


Figure 9 Cesium sensor dead zones in the northern hemisphere.

DETERMINING OPERATING ZONES

1. To determine the operating zones of the SMARTMAG, face north and swing the sensor head to the ground and then upwards. This will enable you to determine the angular range of operation by either the audio or display reading. When the sensor head is out of the operating range, the audio will vary wildy and the display reading will go out of range (range 20,000 to 99,999 nT). Preferably, the staff should be oriented so that it lies in the center of the angular range as just described.
2. While facing magnetic north, the range of sweep operation may be determined by swinging the SMARTMAG staff to the left and then to the right. The usable sweep angle will depend on your geographical position. If sweep operations are then conducted while walking in a northerly direction, the allowable sweep motion will be known by the previous test.
3. To determine the proper staff position and sweep angle for walking south, perform the previous tests while facing south.

ADJUSTING THE SENSOR HEAD ANGLE

1. Adjust the angle of the sensor head relative to the staff by loosening the brass wing nut and then swiveling the head. The head should be positioned so that it is in the centre of the operating zone and that it does not enter a dead zone during a survey operation.
2. When the sensor head is in the appropriate position, tighten the brass wing nut.

THE SMARTMAG MODEL SM—4

This chapter is about the SMARTMAG model SM–4 which contains a full featured LCD console. The SM–4 console has full storage for recording numerical and graphical data. The SM–4 features:

- adjustable cesium sensor with rigid staff,
- SMARTMAG Console featuring:
  - graphics display
  - full keyboard
  - 310,000 Readings —Total Field
  - 750,000 Reading —Base Station
  - Non-magnetic waterproof construction

RECEIVING YOUR INSTRUMENT

On receipt of your instrument, carefully inspect the shipping or carrying case for damage. Also ensure that you have received all required assemblies by checking against your order, as systems may vary.

THE COMPONENTS

The basic SM–4 (part no. 759 003) consists of the following assemblies (see "Instrument parts list" on page 11–4 for more details):

- SMARTMAG main assembly (759 009)
- Rechargeable battery belt (759 043)
- 110/220 VAC battery charger (400 151)
- Shoulder strap (759 504)
- SMARTMAG minor spare parts kit (759 039)
- SMARTMAG console (759 012)
- Rechargeable battery (400 078)
- 110/220 VAC battery charger (400 139)
- Console minor spare parts kit (788 030)
- RS-232 Cable (745 081)
- SMARTMAG SM–4/4G Information kit (759 534)
- Transit case (759 505)

ASSEMBLING THE INSTRUMENT

The shoulder strap assembly are not attached to the instrument when shipped. The shoulder strap is attached to the staff by way of clips that are snapped on and then screw tightened. The clamps are to be positioned on either side of the black foam handle on the staff. This will require some experimentation to find the most comfortable position for the individual user.

CONNECTING THE CABLES

In order to operate the SMARTMAG you must provide power to the staff assembly by connecting the cable (with 10 pin KPT connector) from the battery belt (this connector is labeled 'TOTAL') to the mating connector on the face plate. This connector is locked by rotating the mounting ring on the connector in a clockwise direction. (See "Connecting the sensor(s) to the Battery Belt" on page 2–5.) (Cable P/N 759 513)

The optional LED display and keypad is similarly connected to the other connector (10 pin KPT) on the face plate.

The headphones are connected to its signal cable coming from the center of the battery belt box.

The SMARTMAG console is connected via RS-232 cable (with dual 4-pin KPT cable P/N 759 514) to the battery belt box. Connect the 'Data Output' connector on the SMARTMAG console to the 4-pin RS-232 connector on the battery belt box. This 4 pin RS-232 connector is on the bottom of the battery belt box, and is adjacent to the 10 pin 'TOTAL' connector.

SETTING UP THE INSTRUMENT

TURNING ON THE INSTRUMENT

1. Set the 3-position switch in the battery belt to the ON position. The amber coloured LED will then light.
2. Press and release the RESET push-button switch on the face plate of the SMARTMAG.

   If the 3-position switch in the battery belt is put in the center or STBY (standby) position, the sensor head power is removed but digital electronics remains powered. This mode may be used when learning the display functions if you want to conserve battery power.

Note: The instrument operates from battery power only — the charger will not power the instrument and the charger will not charge the batteries in any position other than the OFF position of the 3-position switch.

USING THE HEADPHONES

The headphones are connected to the black plastic connector at the end of the cable coming from the bottom of the battery belt. The headphones are monaural and have a single volume control on the right hand cup.

The sensitivity of the headphone is set by the PITCH parameter on the SMARTMAG console. Alternatively, the sensitivity of the headphones can be set with the Audio function accessed by the LED display and keyboard described below.

SETTING THE PARAMETERS WITH THE CONSOLE

Prior to operating a survey, it is necessary to enter certain parameters into the SMARTMAG console. These include:

- hemisphere of operation
- local field value
- audio sensitivity
- sample rate
- filter bandwidth

These parameters are downloaded into the sensor wand from the SMARTMAG console when the START key is first pressed on the console. The message initializing will be displayed on the SMARTMAG console LCD display. If a communication error results, press and release the RESET button on the SMARTMAG faceplate.

Note: SM–4 users (and particularly SM–4G users) will find the LED display and keypad useful for verifying that the sensor wands have reset and are fully functioning. Please refer to Chapter 6 for a full description of the SMARTMAG console.

USING THE LED DISPLAY AND KEYPAD

Note: The SM–4 may be used as a *search* magnetometer using the optional LED display and keyboard in place of the console.

The parameters may be set from the LED display and keyboard assembly which consists of an 8 digit, sunlight readable display and a four key keyboard. The keys are labeled with both arrows and numbers (1, 2, 3, 4). The functions are as follows:

KEYPAD

Function key–(1 key, right arrow) This key is used to enter and exit functions. The available functions may be viewed by using the scroll keys.

Scroll keys–(2 key, up arrow; 3 key, down arrow) These keys are used to scroll or scan through functions. Once a function has been selected or entered (by pressing Key 1), the scroll keys are then used to scroll or scan through the options provided by that function.

Auxiliary Key–(4 key, left arrow) The auxiliary key is currently reserved for future use.

DISPLAYS AND FUNCTIONS

Function ' ' (blank display)

This display shows the total field value in nT.

1. Press the ▲ or ▼ scroll key until the ' ' (blank display) is displayed.
2. Press the ▶ function key to display the total field value in nT.
3. Press the ▶ function key to exit this parameter.

Function
north
South

Select this function to enter in the North or South hemisphere. In order to operate properly, the hemisphere setting must be set according to the hemisphere that the instrument is being operated in. If you are operating in the northern hemisphere, (Canada, USA, Japan etc.) select north, Otherwise, select South. The default power up setting of the SMARTMAG is for northern hemisphere operation.

1. Press the ▲ or ▼ scroll key until the either north or South is displayed.
2. Press the ▶ function key to access the setting.
3. Press the ▲ or ▼ scroll key to select either north or south.
4. When you have selected the appropriate hemisphere, press the ▶ function key to exit this parameter,

Function
Audio

Select this function to set the sensitivity of the audio headphones. The sensitivity can be set from 0 to 990 in increments of 10.

1. Press the ▲ or ▼ scroll key until Audio is displayed.
2. Press the ▶ function key to access the setting.
3. Press the ▲ or ▼ scroll key until the appropriate sensitivity is selected. The sensitivity can be set from 0 through 990 in increments of 10. The default is 100. Use a smaller value for less sensitivity and a larger value for greater sensitivity.

Function
LoPAS

Select this function to set the low-pass filter bandwidth in Hz of the displayed data. This function does not affect audio information. The visual display of the total magnetic field may be used to supplement the audio information. The bandwidth settings are 0.5, 1.0, 2.0, 4.0 and 8.0 Hz (optionally higher bandwidths are available).

1. Press the ▲ or ▼ scroll key until the LoPAS is displayed.
2. Press the ▶ function key to access the setting.
3. Press the ▲ or ▼ scroll key until the appropriate bandwidth is selected. The bandwidth can be set to 0.5, 1.0, 2.0, 4.0 or 8 Hz (or optionally higher).

Note: Bandwidths and sample rates are independent — data may be obtained at the highest sample rate regardless of the bandwidth setting.

Function
FLASH

Select this function to program the FLASH memory

1. Press the ▲ or ▼ scroll key until FLASH is displayed.
2. Press the ▶ function key to access the setting.
3. Press the ▲ key to increment the displayed number from 0 to 10 in increments of 1 (0, 1, 2, … 10). When 10 is reached, the SMARTMAG will be ready to receive its new operating program from a PC via RS-232 at 19,200 baud. This requires:
    1. The PC program FASTCOM
    2. A downloadable sys file *.SYS
    3. RS-232 cable to connect the battery belt's 4 pin KPT connector to PC

Function
rAtE

Access this function to select the LED display update rate of 1, 2, 5 or 10 readings per second.

Function
FIELd

Access this function to set the local field strength in 1,000's of nT to the nearest 5,000 nT. This parameter does not have to be correctly set for the SMARTMAG to function, so you can determine the correct value of the field by measuring the field with the SMARTMAG. Some examples of field settings are:

Local Field:	Set FIELd to:
23,000 nT	25 (for 25,000 nT)
57,000 nT	55 (for 55,000 nT)
90,000 nT	90 (for 90,000 nT)

The field parameter may be set ± 10 without effect. If the field is grossly out of setting, bandwidth settings will not be correct. To set the field:

1. Press the ▲ or ▼ scroll key until FIELd is displayed.
2. Press the ▶ function key to access the setting.
3. Use the ▲ or ▼ scroll key to increment or decrement the field strength by 5 (5,000 nT).

Warning: Users who operate with both the LED display and keypad and SMARTMAG console simultaneously should configure the operating parameters in the SMARTMAG console only. Changes made to the operation parameters such as bandwidth via the LED display and keypad while in the process of data collection will be recognized by the sensor wand processor but will not be recorded in the SMARTMAG console header information.

PERFORMING A SURVEY

See the SMARTMAG Applications booklet for details on how to perform a survey.

THE SMARTMAG MODEL SM—4G

This chapter is about the SMARTMAG model SM–4G which contains a full featured LCD console and the gradiometer option. The SM–4G console has full storage for recording numerical and graphical data. The SM–4G features:

- gradiometer interconnect poles.
- two cesium sensors with adjustable sensor orientation,
- SMARTMAG Console featuring:
  - graphics display
  - non-magnetic water proof construction
  - storage for 190,000 gradiometer readings
  - full keyboard

RECEIVING YOUR INSTRUMENT

On receipt of your instrument, carefully inspect the shipping or carrying case for any damage. Also, please ensure that you have received all required assemblies by checking against your order, as systems may vary.

THE COMPONENTS

The basic SM–4G SMARTMAG (part no. 759 004) consists of the following assemblies (see also "Instrument parts list" on page 11–4):

- SMARTMAG main assembly (759 009)
- Rechargeable battery belt (759 043)
- 110/220 VAC battery charger (400 151)
- Shoulder harness (759 504)
- SMARTMAG minor spare parts kit (759 039)
- SMARTMAG console (759 012)
- Rechargeable battery (400 078)
- 110/220 VAC battery charger (400 139)
- Console minor spare parts kit (788 030)
- RS-232 Cable (745 081)
- Gradiometer mounting kit (759 082)
- SMARTMAG SM–4/4G Information kit (759 534)
- Transit case (759 505)

ASSEMBLING THE INSTRUMENT

The shoulder strap assembly is not attached to the instrument when shipped. The shoulder strap is attached to the staff by means of clips that are snapped on and then screw tightened. The clamps are to be positioned on either side of the black foam handle on the staff. This will require some experimentation to find the most comfortable position for the individual user.

MASTER PROCESSOR

When operating in the Gradiometer configuration with two sensor wands, the wand connected to the battery belt TOTAL connector (10 pin KPT) will process both the Total and Gradiometer signals. The

TOTAL sensor wand transmits both total and gradiometer data to the SMARTMAG console via the 4 pin KPT connector on the bottom of the battery box (this connector is adjacent to the TOTAL connector).

Note: The TOTAL sensor wand must be internally jumpered to operate as a master processor. The GRAD sensor must be also internally jumpered to operate as a slave processor.

When receiving a SM–4G system, the TOTAL (or master) and GRAD (or slave) sensor wands will be labelled.

Warning: Please consult the SCINTREX factory for information on changing these configurations. Note that both master and slave processor wands may be used as is for performing total field surveys.

CONNECTING THE CABLES

In order to operate the SMARTMAG you must provide power to the staff assembly by connecting the cable (with 10 pin KPT connector) from the battery belt (this connector is labeled TOTAL) to the mating connector on the face plate. This connector is locked by rotating the mounting ring on the connector in a clockwise direction. (See "Connecting the sensor(s) to the Battery Belt" on page 2–5.). (Cable P/N 759 513)

Similarly, the gradiometer sensor is connected to the battery belt connector labelled GRAD.

The optional LED display and keypad is similarly connected to the other connector (10 pin KPT) on the face plate.

The headphones are connected to its signal cable coming from the center of the battery belt box.

The SMARTMAG console is connected via RS-232 cable (with dual 4-pin KPT cable P/N 759 514) to the battery belt box. Connect the 'Data Output' connector on the SMARTMAG console to the 4 pin RS-232 connector on the battery belt box. This 4 pin RS-232 connector is on the bottom of the battery belt box and is adjacent to the 10 pin TOTAL connector.

SETTING UP THE INSTRUMENT

TURNING ON THE INSTRUMENT

1. Set the 3-position switch in the battery belt to the ON position. The amber coloured LED will then light.
2. Press and release the RESET push-button switch on the face plate of the SMARTMAG. (Gradiometer: press both buttons on each of the face plates.)

   If the 3-position switch in the battery belt is put in the center or STBY (standby) position, the sensor head power is removed but digital electronics remains powered. This mode may be used when learning the display functions if you want to conserve battery power.

Note: The instrument operates from battery power only — the charger will not charge the batteries in any position other than the OFF position of the 3-position switch.

USING THE HEADPHONES

The headphones are connected to the black plastic connector at the end of the cable coming from the center of the battery belt. The headphones are monaural and have one volume control on the right hand cup.

The sensitivity of the headphones is set by the PITCH parameter in the SMARTMAG console. Alternatively, the sensitivity of the headphones can be set in the Audio function accessed by the LED display and keyboard described in the following sections.

SETTING THE PARAMETERS WITH THE SMARTMAG CONSOLE

Prior to operating a survey, it is necessary to enter certain parameters into the SMARTMAG console. These include:

- ▲ sample rate
- ▲ local field value
- ▲ hemisphere of operation
- ▲ filter bandwidth
- ▲ audio sensitivity

These parameters are downloaded into the sensor wand from the SMARTMAG console when the START key is first pressed on the console. The message `initializing` will be displayed on the SMARTMAG console LCD display. If a communication error results, press and release the RESET button on the SMARTMAG faceplate (or both RESET buttons for the SM–4G.

Note: SM–4 users (and particularly SM–4G users) will find the LED display and keypad useful for verifying that the sensor wands have reset and are fully functioning. Refer to Chapter 6 for a full description of the SMARTMAG console.

USING THE LED DISPLAY AND KEYPAD

The SM–4G may be used as *search* magnetometer/gradiometer using the optional LED display and keyboard in place of the LCD console.

The parameters may be set from the LED display and keyboard assembly which consists of an eight digit, sunlight readable display and a four key keyboard. The keys are labeled with both arrows and numbers (1,2,3,4). The functions are as follows:

KEYPAD

Function key–(1 key, right arrow) This key is used to enter and exit functions. The available functions may be viewed by using the scroll keys

Scroll keys–(2 key, up arrow; 3 key, down arrow) These keys are used to scroll or scan through functions. Once a function has been selected or entered (by pressing Key 1), the scroll keys are then used to scroll or scan through the options provided by that function.

Auxiliary Key–(4 key, left arrow) The auxiliary key is currently reserved for future use.

DISPLAYS AND FUNCTIONS

Function ' ' (blank display)

This display shows the total field value in nT.

1. Press the ▲ or ▼ scroll key until the ' ' (blank display) is displayed.
2. Press the ▶ function key to display the total field value in nT.
3. Press the ▶ function key to exit this parameter.

Function north South

Select this function to enter in the North or South hemisphere. In order to operate properly, the hemisphere setting must be set according to the hemisphere that the instrument is being operated in. If you are operating in the northern hemisphere, (Canada, USA, Japan etc.) select north, Otherwise, select South. The default power up setting of the SMARTMAG is for northern hemisphere operation.

1. Press the ▲ or ▼ scroll key until the either north or South is displayed.
2. Press the ▶ function key to access the setting.
3. Press the ▲ or ▼ scroll key to select either north or south.
4. When you have selected the appropriate hemisphere, press the ▶ function key to exit this parameter,

Function
Audio

Select this function to set the sensitivity of the audio headphones. The sensitivity can be set from 0 to 990 in increments of 10.

1. Press the ▲ or ▼ scroll key until Audio is displayed.
2. Press the ▶ function key to access the setting.
3. Press the ▲ or ▼ scroll key until the appropriate sensitivity is selected. The sensitivity can be set from 0 through 990 in increments of 10. The default is 100. Use a smaller value for less sensitivity and a larger value for greater sensitivity.

Function
LoPAS

Select this function to set the low-pass filter bandwidth in Hz of the displayed data. This function does not affect audio information. The visual display of the total magnetic field may be used to supplement the audio information. The bandwidth settings are 0.5, 1.0, 2.0, 4.0 and 8.0 Hz (optionally higher bandwidths are available).

1. Press the ▲ or ▼ scroll key until the LoPAS is displayed.
2. Press the ▶ function key to access the setting.
3. Press the ▲ or ▼ scroll key until the appropriate bandwidth is selected. The bandwidth can be set to 0.5, 1.0, 2.0, 4.0 or 8 Hz (or optionally higher).

Note: Bandwidths and sample rates are independent — data may be obtained at the highest sample rate regardless of the bandwidth setting.

Function
FLASH

Select this function to program the FLASH memory

1. Press the ▲ or ▼ scroll key until FLASH is displayed.
2. Press the ▶ function key to access the setting.
3. Press the ▲ key to increment the displayed number from 0 to 10 in increments of 1 (0, 1, 2, … 10). When 10 is reached, the SMARTMAG will be ready to receive its new operating program from a PC via RS-232 at 19,200 baud. This requires:

1. The PC program FASTCOM
2. A downloadable sys file *.SYS
3. RS-232 cable to connect the battery belt's 4 pin KPT connector to PC

Function
rAtE

Access this function to select the LED display update rate of 1, 2, 5 or 10 readings per second.

Function
FIELd

Access this function to set the local field strength in 1,000's of nT to the nearest 5,000 nT. This parameter does not have to be correctly set for the SMARTMAG to function, so you can determine the correct value of the field by measuring the field with the SMARTMAG. Some examples of field settings are:

Local Field:	Set FIELd to:
23,000 nT	25 (for 25,000 nT)
57,000 nT	55 (for 55,000 nT)
90,000 nT	90 (for 90,000 nT)

The field parameter may be set ± 10 without effect. If the field is grossly out of setting, bandwidth settings will not be correct. To set the field:

1. Press the ▲ or ▼ scroll key until FIELd is displayed.
2. Press the ▶ function key to access the setting.
3. Use the ▲ or ▼ scroll keys to increment or decrement the field strength by 5 (5,000 nT).

Warning: Users who operate with both the LED display and keypad and SMARTMAG console simultaneously should configure the operating parameters in the SMARTMAG console only. Changes made to the operation parameters such as bandwidth via the LED display and keypad while in the process of data collection will be recognized by the sensor wand processor but will not be recorded in the SMARTMAG console header information.

ASSEMBLING THE GRADIOMETER

The gradiometer option can be assembled either horizontally or vertically. The gradiometer kit has six 0.5 metre inter-connecting poles.

Vertical Gradiometer

The vertical gradiometer is configured by using two 0.5 metre inter-connecting poles to attain a vertical separation between the two sensor staff assemblies, as shown in the diagram below:

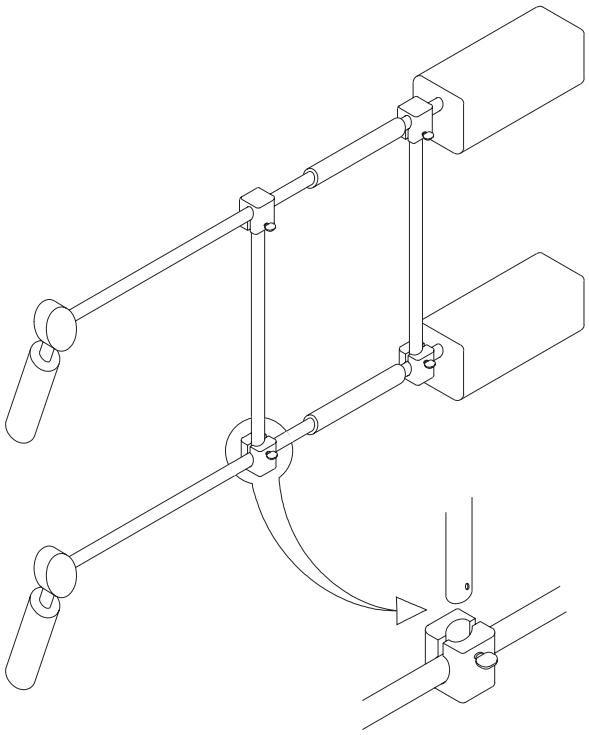


Figure 10 Assembling the Vertical Gradiometer

Horizontal Gradiometer

In the horizontal gradiometer assembly, there are two options. The gradiometer separation in the horizontal position can be 0.5, 1.0 or 1.5 metres. The separation is achieved by the number of inter-connecting polesused in the configuration. For example, if you require a 1.5 metre separation, all of the poles would be used. See the diagram below for a typical horizontal configuration.

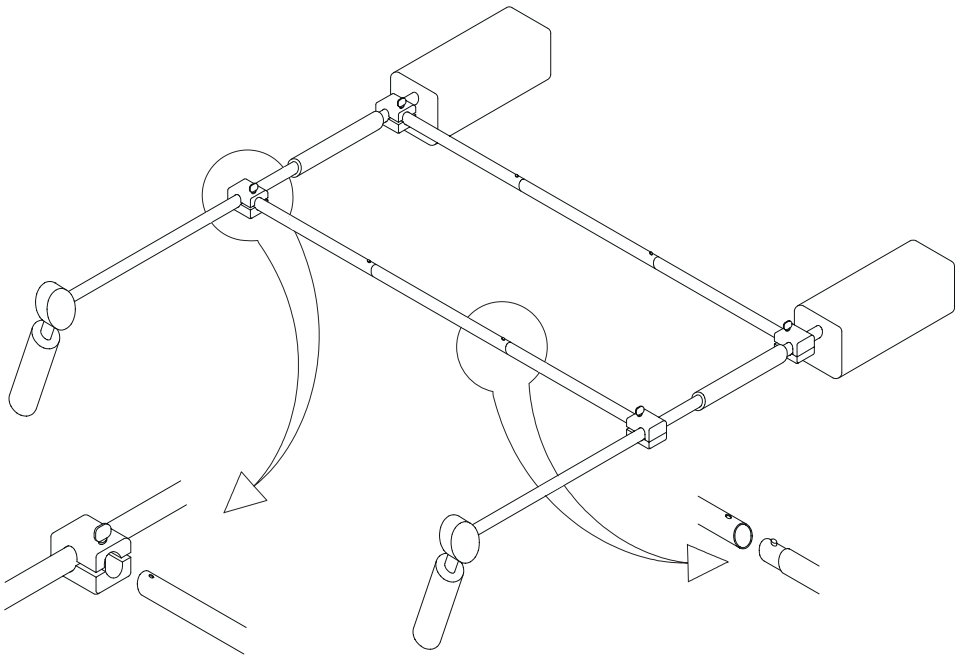


Figure 11 Assembling the Horizontal Gradiometer

PERFORMING A SURVEY

See the SMARTMAG *Applications* booklet for details on how to perform a survey.

THE SMARTMAG CONSOLE

This chapter is about the the SMARTMAG console and fully describes:

- the keypad functions,
- the various display menus,
- the display formats that you will encounter.

PRE-DEFINED OPERATING MODES

To make the SMARTMAG easier to use, it has a menu of seven predefined configurations, in three modes, to choose from. The menu is obtained by pressing the "SETUP + ON" keys simultaneously.

BASIC

- used for site characterization, buried ordnance detection, drum location and archaeology
- operates in the WALKMAG mode (continuous reading)
- does not have on-line data recall features; you have to dump the data to a computer to inspect it—you can still see a graphical display of the data
- data correction is from a base-station or the TIE-PT Loop mode
- real-time graphic display of the data

SEARCH

- operates in a continuous reading mode, but the data is *not* stored in memory
- you can see a graphical display of the data as it is collected
- real-time graphic display of the data

ADVANCED

- used for ground water, mineral, oil and gas exploration or detailed site characterization, drum location, archaeology, etc.
- allows you to adjust *all* possible parameters of the SMARTMAG
- real-time graphic display of the data

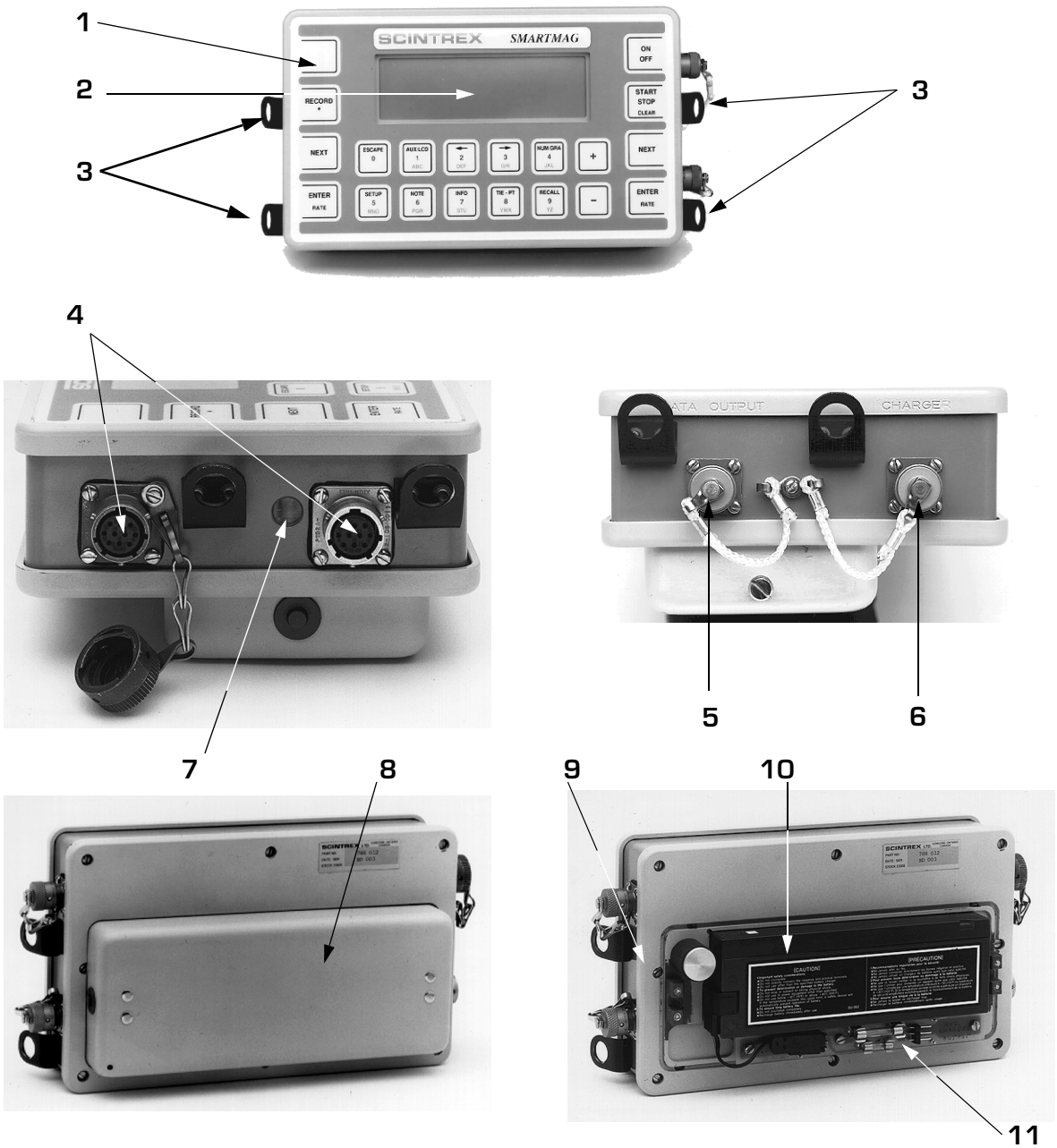


Figure 12 The SMARTMAG console.

*CONSOLE DESCRIPTION

#	Item	Description
1	Keypad	The fully sealed Keypad has 19 keys and a sound port.
2	Liquid Crystal Display (LCD)	The large 8 line by 40 character (64 x 240 dots) Supertwist LCD (with a wide temperature range) presents status and data in numeric or graphic format.
3	Carrying Strap Attachment	Four rings at the side of the console allow attachment of the carrying harness.
4	*Sensor Connectors	Up to two sensor connectors may be present at the left hand side of the console. The nearer one (J102) is reserved for the magnetometer.
5	Data Output Connector	The data output connector carries RS-232 data dump signals, as well as the analog signal for a strip chart recorder and is located at the right hand side of the console. It has the following pin assignments: **A** - common (ground), **C** - RS-232 transmit data, **B** - RS-232 receive data. **D** - analog out 0 - 1 Volt,
6	Charger/ External Power Connector	This connector accepts the charger to recharge either the standard battery or the external heavy-duty battery pack. It also accepts external, well filtered, 11 to 16 Volt DC input. The center pin is negative (–). The shell is positive (+).
7	Charging Light	The charging light is visible through a window at the left side of the console. It is lit while the battery is charging at a high rate.
8	Battery Compartment	The battery compartment is located at the back of the console and contains one rechargeable lead-acid battery, the desiccant cartridge and the fuse. The battery cover is replaced with another cover with a cable attached when the external battery is used.
9	Desiccant Cartridge	The desiccant cartridge is a cylindrical re-usable capsule filled with a drying agent. It absorbs any moisture that may get inside the instrument.
10	Battery	A rechargeable lead-acid battery in the standard SMARTMAG configuration.
11	Fuse	The standard 1.5A fuse to use with the standard battery.

*** The number of sensor connectors may vary depending upon configuration**

KEYPAD DESCRIPTION

The keypad has 19 keys. Two of the most used keys are duplicated on the right and left sides of the console for easy access. Some keys have up to three separate functions assigned to them. The response of these multi-function keys depends upon the operation in progress.

Note: The function mode of the keys has precedence over the alphanumeric mode of the keys

.

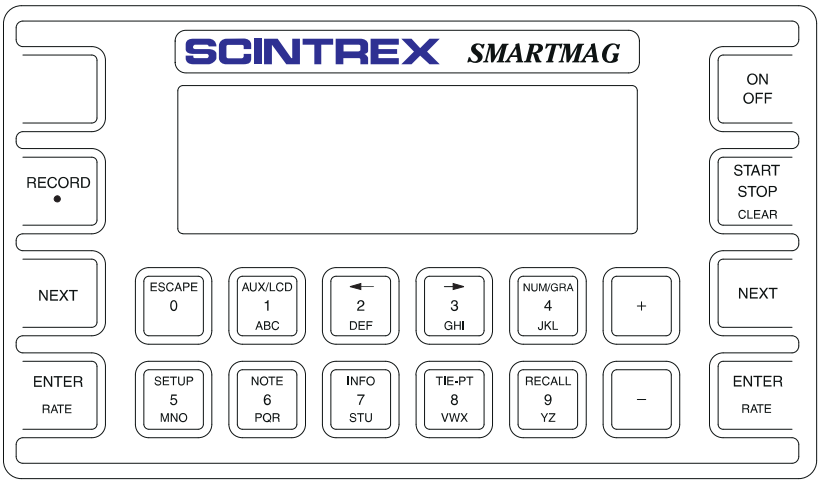
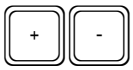


Figure 13 The SMARTMAG console keypad.

KEY FUNCTIONS

Key	Description
	Turns the instrument on and off. Turning the instrument off during a reading abruptly terminates a reading with the loss of the current data.
	Starts or stops an operation, such as data acquisition, data dumping, data recall, etc. *When the instrument is in the Notes operation, this button acts as a "backspace" key to delete entries.
	*Accesses the various setup displays. The actual setup menu that will be displayed depends upon the display screen in which this key is pressed.
	*Accesses the Auxiliary Functions display allowing: ▲ setting of the LCD intensity, ▲ data output, ▲ locking of the setup parameters, ▲ reprogramming of the main system software (EEPROM).
	Moves the cursor to the left or up; to the right or down, ▲ scrolls sequentially through graphic display pages (online), ▲ scrolls sequentially through graphic display pages (recall).
	Two identical keys: ▲ opens and closes the parameter fields during setups, ▲ opens and closes the scaling option field for the graphics display, ▲ toggles the sample rate in the walking type survey.
	Allows escape from a deeper level in a program to a higher level, ultimately to the top level, which is signified by the Main operating display. Aborts a data dump.

Key	Description
	*Accesses the Info. Display, which allows: ▲ setting of date and time, ▲ entering of serial and job numbers and operator identification, ▲ observation of memory availability.
	Two identical keys: ▲ moves the cursor from one sub-page to the next sub-page, ▲ moves the cursor to the next character location during note entry, ▲ advances the station number by station separation in the walking mode.
	*Accesses the Note Entry display, which allows: ▲ the entry of five common notes (macros) to be recorded repeatedly with selected readings, ▲ the entry of unique notes to be recorded with a particular reading.
	Toggles the data display between numerical and graphic data presentation during data acquisition only.
	*Presents the Recall display for selection of: ▲ data item to be recalled, ▲ setting of the starting location or time of the recall.
	*Manually records measured data and notes in internal memory.
	Acts as the START key at a Tie-point. This is used for the Tie-point line and loop mode corrections.

Key	Description
	Facilitates the scrolling forward or backward through a list of items: ▲ allows sign entry to numbers, ▲ allows panning along a line of data during recall, ▲ increments or decrements the line and station number in the Stop-and-Go mode.
1-9, ., A-Z	*Allows alpha-numeric entry for setups and notes.
BEEPER PORT	This blank "key" in the upper left corner of the console is not actually a key, but a flexible membrane to enhance the loudness of the beeper.
	Pressing the "ON" and "AUX/LCD" keys simultaneously performs the COLD BOOT operation, resetting the instrument to factory defaults.
	Pressing the "ON" and "SETUP" keys simultaneously allows you to select between Basic, Search or Advanced modes.

*These items/key functions are only operational when you select the *advanced* operating modes (options 5 to 7) from the initial configuration menu.

DISPLAY SCREENS

The SMARTMAG currently has seven preset configurations. Depending upon which of the configurations you choose to survey with, you may not see all of the various types of displays:

- ▲ configuration selection menus
- ▲ help screens
- ▲ confirmation screens
- ▲ parameter selection screens
- ▲ note entry screens
- ▲ numeric data displays
- ▲ graphical data displays
- ▲ pop-up options and confirmations

GENERAL INFORMATION

Most of the screens contain three bands of information as shown below:

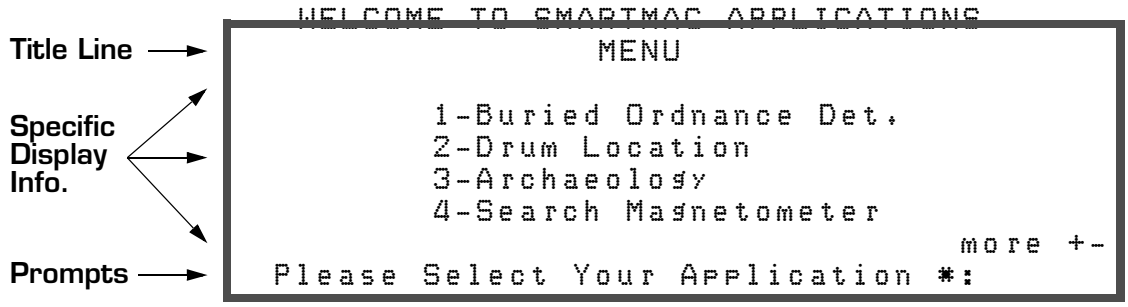


Figure 14 General display information bands

1. The **Title Line** at the top indicates the current operating functions.
2. The middle six lines contain specific display information consisting of either instrument and survey parameters or data.
3. The bottom line usually contains prompts for actions, such as pressing the key required to start an operation. Miscellaneous

messages may also appear here. The battery voltage (a value between 100 and 140) is also shown on the right-side of this line.

Note: The instrument automatically turns off (blank display) to conserve battery power, if there is no reading or key stroke detected for one minute.

Cursor

A large, blinking *cursor* ( ) indicates the specific parameter that can be altered to change setups, starting station value, station or line spacing, and so on. The cursor is moved from parameter to parameter or line to line by pressing the arrow (← →) keys to move in the desired direction. The prompt on the bottom line will let you know which key to press to make any changes.

Display blocks

Some displays are divided into two or more *blocks* or sub-panels. The blocks are separated by solid partition lines as shown in the following figure.

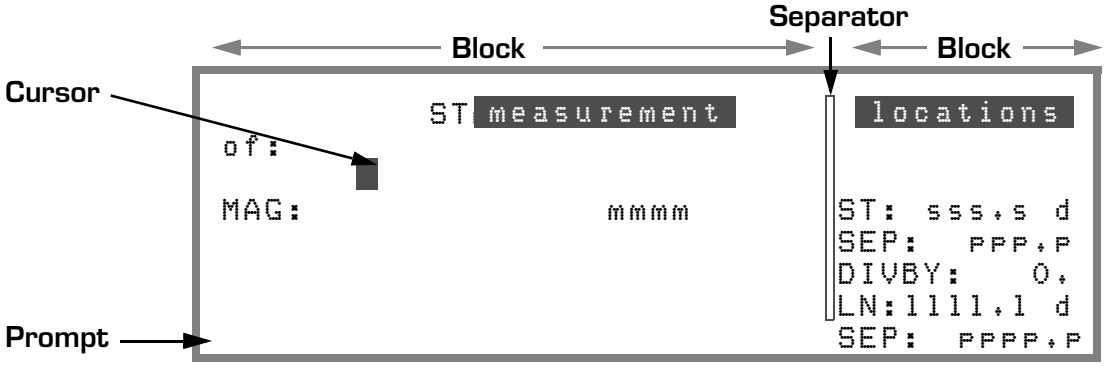


Figure 15 Instrument display showing information blocks (sub-panels)

To move the cursor from one block to another, **press** the "NEXT" key.

Some measured data is displayed on more than one *page* (display screen). Switching between pages is also done by pressing the "NEXT" key. The display screens are designed so that these multi-page displays do not have separate sub-blocks. All of this is discussed in detail under "Advanced mode data displays" on page A6–27.

Pop-up windows

Some displays will have pop-up windows (either on the right or left side of the main display) that will contain:

- prompts for selecting or changing parameters
- confirmations and warnings of impending operations requiring a `Y` (yes) or `N` (no) entry from the keypad
- status indication of an operation under way, such as data output

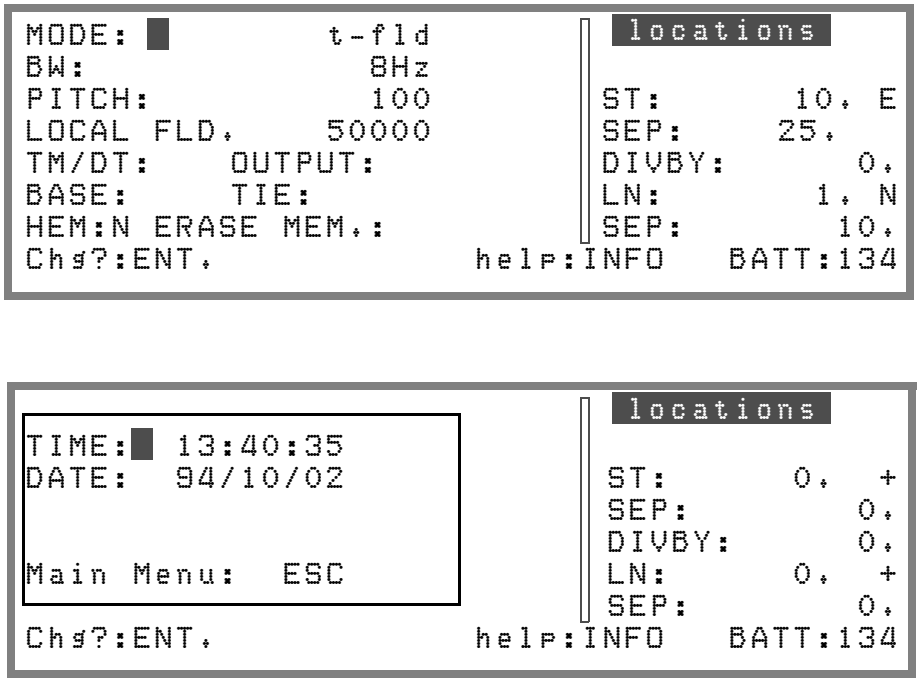


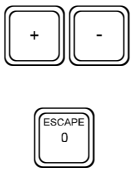
Figure 16 Sample pop-up windows

Help screens

On-line help is also available. There are three screens of information providing a quick reference on how to do most operations and which buttons to push. The screens are as follows:

Figure 17 Help screens available

The help screens are displayed when you press the "INFO" button. Whenever you see the text `help:INFO` in the bottom prompt line of a display, you can activate the help screens.



To toggle to the another help screen, press the "+" or "–" key. The screens change in a cyclical manner as shown in the above figure.

To return to the main operating menu, press the "ESC" key.

OPERATING DISPLAYS

The various display screens will be discussed in groups according to the configuration modes—basic, search or advanced.

BASIC MODE CONFIGURATION DISPLAYS

The basic mode of operation is in effect when you select either of these configuration options after pressing the "SETUP+ON" keys simultaneously:

1. Buried Ordnance Det.
2. Drum Location
3. Archaeology

The following is the general layout of the Main operating display in the basic mode:

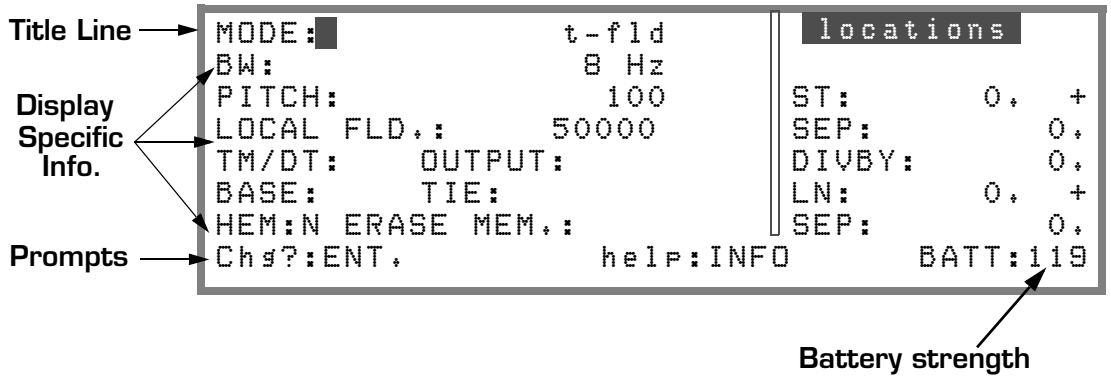


Figure 18 General display layout

The following table describes all the parameters in the two blocks of the main menu:

Parameter	Description
MODE	Allows you to select the SMARTMAG operating mode: ▲ total-field magnetometer ▲ gradiometer ▲ base You must press the "+" or "–" keys to toggle between the modes.
BW	Bandwidth. You have a choice of 0.5, 1, 2, 4 or 8 Hz (or optionally higher bandwidths).
PITCH	This is the audio headphone sensitivity. You can select in increments of 10 from 0 to 990. The default is set to 100.
LOCAL FLD.	The value of the Earth's ambient magnetic field in the survey area. For best performance the local field should match the ambient field as closely as possible, at least to within ±10,000 nT.
TM/DT	This option allows you to set the time and date of your SMARTMAG. You must press the "ENTER" key. A pop-up window will be displayed showing the current values of TIME and DATE in your instrument. Use the arrow keys to move the blinking cursor to the field you wish to change. Press "ENTER" again and enter the value from the keypad. Finish the entry by pressing "ENTER" one more time. To get back to the main menu, press the "ESC" key. NOTE: If you will be using a base-station to correct the data, you must ensure that the date and time of both units are the same BEFORE you start collecting data.

Parameter	Description
OUTPUT	This option dumps your data to a computer via the serial port. The communications mode is fixed to 9600 baud, 8 bits, 1 stop bit and no parity. The format will be XYZ+. You must press the "ENTER" key. An information pop-up will be displayed telling you to press the "START" key when you are ready. You must have a computer connected using the supplied RS-232 cable (SCINTREX part no. 745 081) and you should be running the ENVIMAP software (*Prepare the Data:Dump instrument data* menu option)
BASE	This option applies a BASE-STATION correction using data supplied from a base-station SMARTMAG. You must press the "ENTER" key. You need to have the base-station connected as described in "Base-station operation" on page A8–11. A request for confirmation will be displayed in a pop-up window before your data is corrected. You must press the "9/YZ" (Yes) key to begin or the "5/MNO" (No) key to abort. NOTE: The original raw data is changed.
TIE	This applies the LOOP mode correction to collected data. You must press the "ENTER" key. A request for confirmation will be displayed in a pop-up window before your data is corrected. You must press the "9/YZ" key to begin or the "5/MNO" key to abort. NOTE: The original raw data is changed.
HEM	This function sets the hemisphere function of either north or south. N=north, S=south
ERASE MEMORY	Allows clearing of the data memory. You must press the "ENTER" key. A request for confirmation will be displayed in a pop-up window before the actual erasure takes place. You must press the "9/YZ" (Yes) key to begin or the "5/MNO" (No) key to abort. NOTE: The rest of the setup parameters remain intact.

Parameter	Description
ST	The station number for this measurement. It consists of the numeric part (sss.s) and the directional part (d). The range is from 0 to 99999 with a decimal point as required. The direction allows the entry of the geographical direction or the Cartesian co-ordinates. The allowed entries are: N,E,S,W, + or –.
SEP	The line or station separation. The range is from 0 to 99999 with a decimal point, as required, and can either be positive (+) or negative (–). It may not necessarily represent the reading separation. When the separation is positive, the station number gets incremented by the separation. When the separation is negative, the station number gets decremented by the separation. NOTE: a negative (W,S,–) station, when incremented, becomes less negative, and vice versa.
DIVBY	Trigger switch closure counter. See “SMARTMAG Distance Trigger” on page A6–42.
LN	The line number, along which the measurements take place. It consists of the numeric part (llll.l) and the directional part [d]. The range is from 0 to 99999 with a decimal point as required. The direction allows the entry of the geographical direction or the Cartesian co-ordinates and is one of: N,E,S,W, + or –.
Chg?:+_ ENTER	Depending upon which field the cursor is located in, you will see one of these prompts. Chg?:+- allows you to toggle a selection from an internal list by pressing either the “+” or “–” keys. ENTER: Pressing “ENTER” will either pop-up a window for further operation or let you enter a numeric value (terminated by another press of the “ENTER” key)

Parameter	Description
help:INFO	This prompt indicates that the help screens are available when you press the "INFO" key.
BATT	The voltage of the main battery. The normal range is between 100 and approximately 140 when the charger is connected. The instrument may turn off without warning when the value drops below 100 and will not allow more measurements. The data however still remains intact in memory, as long as the main battery remains connected.

Basic mode data collection displays

The numeric display screen during data collection is as follows:

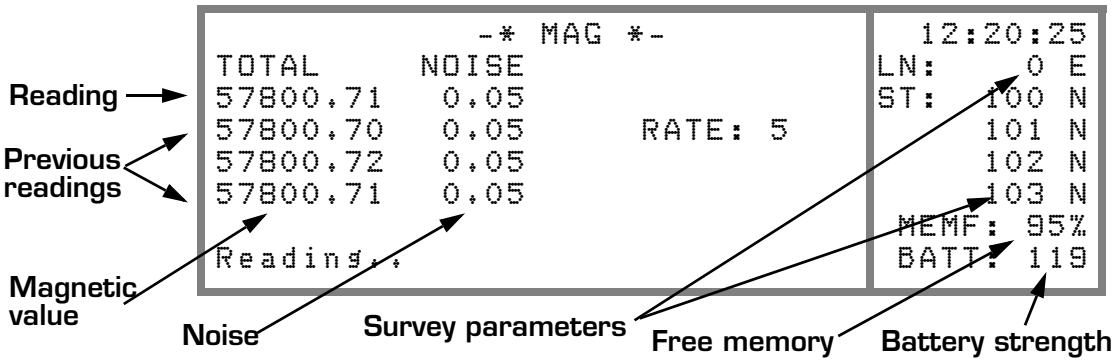


Figure 19 Data collection displays

Note: The sample rate can be set to 1, 2, 5 or 10 samples per second. The default setting is 5 samples per second.

Alternately, during data collection, the data may be displayed graphically.

1. Press the "NUM/GRA" key to display a profile of the data points as they are collected along the line (LN). Up to 178 readings can be displayed. The display appears as follows:

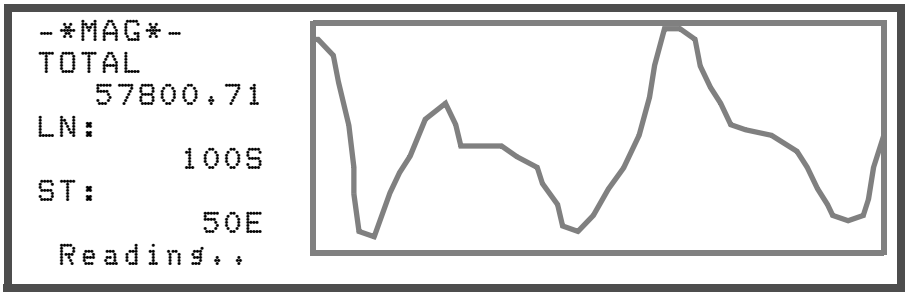


Figure 20 Graphical display of a survey line.

2. While in the graphics mode, you can press the cursor keys to display the alternate graphical displays (gradiometer only).

3. Press the "NUM/GRA" key to return to the numerical diplsay mode from the graphic display mode.

SEARCH MODE CONFIGURATION DISPLAY

This mode is selected when you choose the following option from the configuration menu (available after pressing the "SETUP+ON" keys simultaneously):

4. Search Magnetometer

The Main operating display in the Search mode is as follows:

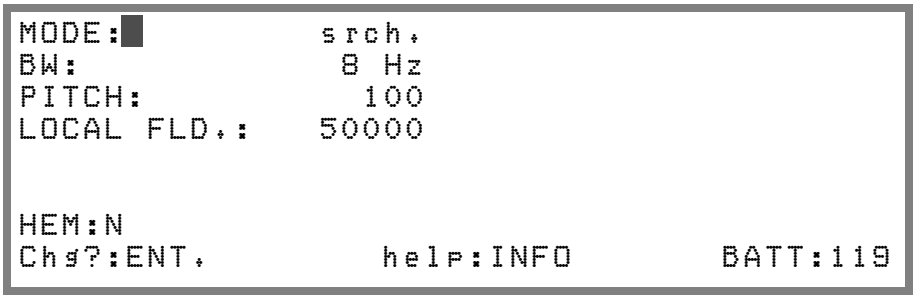


Figure 21 Search mode main display screen

Parameter	Description
MODE	The mode is fixed to "search." The text srch. is displayed as a reminder only.
BW	Bandwidth. Bandwidth and sample rates are independent — data may be obtained at the highest sample rate regardless of the bandwidth setting. You have a choice of 0.5, 1, 2, 4 or 8 Hz (or optionally higher frequencies).
PITCH	This is the audio headphone sensitivity. You can select in increments of 10 from 0 to 990. The default is set to 100.
LOCAL FLD.	The value of the Earth's ambient magnetic field in the survey area. For best performance the local field should match the ambient field as closely as possible, at least to within ±10,000 nT.
HEM	This function sets the hemisphere function of either north or south. N=north, S=south
Chg?+_ ENTER	Depending upon which field the cursor is located in, you will see one of these prompts. Chg?:+- allows you to toggle a selection from an internal list by pressing either the "+" or "–" keys. ENTER: Pressing "ENTER" will either pop-up a window for further operation or let you enter a numeric value (terminated by another press of the "ENTER" key)
help:INFO	This prompt indicates that the help screens are available when you press the "INFO" key.
BATT:	The voltage of the main battery. The normal range is between 100 and approximately 140 when the charger is connected. The instrument may turn off without warning when the value drops below 100 and will not allow more measurements. The data however still remains intact in memory, as long as the main battery remains connected.

Search mode data collection displays

The numeric display screen during data collection is as follows:

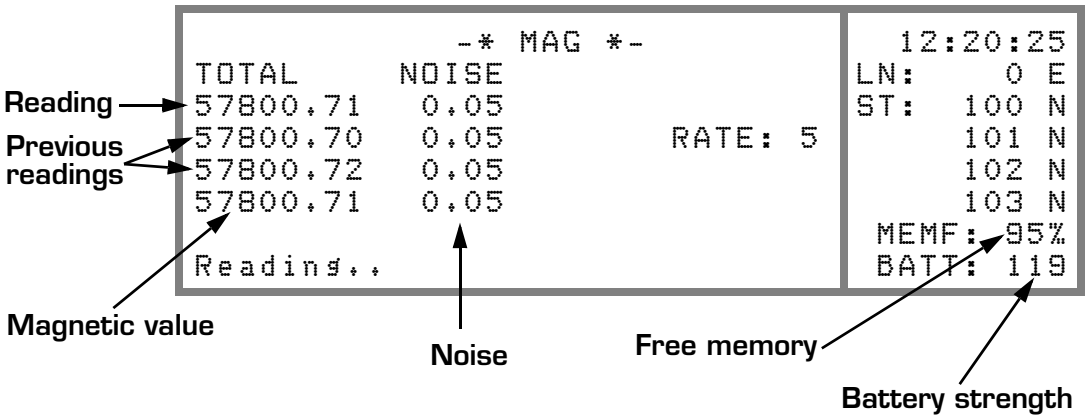


Figure 22 Numeric data collection display during Search mode

Alternately, you can push the "NUM/GRA" key to display a profile (of up to 178 data points) of data as it is collected in the Search mode. The display appears as follows:

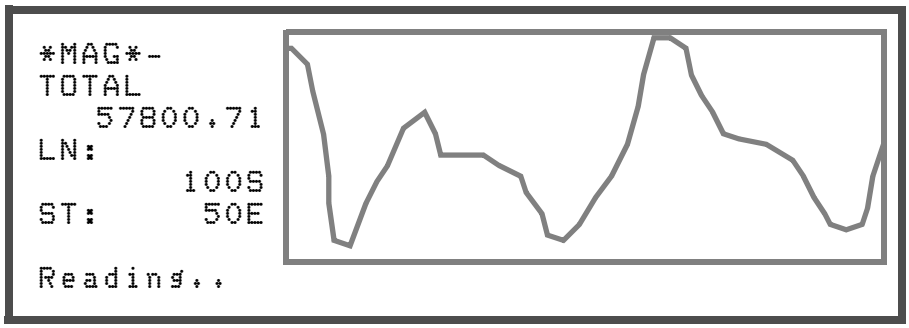


Figure 23 Graphical display during Search mode.

Note: The values that you see for the line and station in the numeric display are the last ones entered in a previous mode. The search mode does not use these for any purpose, so please ignore them.

ADVANCED MODE CONFIGURATION DISPLAYS

The advanced mode of operation is in effect when you select either of these configuration options after pressing the "SETUP+ON" keys simultaneously:

```
5. Ground Water Exploration
6. Mineral Exploration
7. Oil and Gas Exploration
```

Main operating display

The advanced mode Main operating display appears as follows:

```
      START measurement   of: locations

MAG:          mmmm                ST:    sss.s d
                                  SEP:    pppp.p
                                  DIVBY:       0.
                                  LN:   llll.l d
                                  SEP:    pppp.p
Measure:START              ALL Keys  BATT:bbb
```

Figure 24 Main operating display in advanced mode

The configurable parameters of the Main operating display are:

Parameter	Description
MAG	mmm shows which type of magnetometer measurement is currently enabled, and therefore ready to be started.
ST	The station number for this measurement. It consists of the numeric part (ssss.s) and the directional part [d]. The range is from 0 to 99999 with a decimal point as required. The direction allows you to enter the geographical direction or the Cartesian co-ordinates as one of: N,E,S,W, + or –.

Parameter	Description
SEP	The line or station separation. The range is from 0 to 99999 with a decimal point, as required, and can either be positive (+) or negative (–). It may not necessarily represent the reading separation. See the "NEXT" key and AUTO. St. INC. for more information. When the separation is positive, the station number gets incremented by the separation. When the separation is negative, the station number gets decremented by the separation. Note: a *negative* (W,S,–) station, when incremented, becomes *less* negative, and vice versa.
DIVBY	Trigger switch closure counter. See "SMARTMAG Distance Trigger" on page A6–42.
LN	The line number, along which the measurements take place. It consists of the numeric part (1111.1) and the directional part [d]. The range is from 0 to 99999 with a decimal point as required. The direction allows you to enter the geographical direction or the Cartesian co-ordinates as one of: N,E,S,W, + or –.

Instrument setup display

This display enables you to configure the basic data acquisition portion of the SMARTMAG. This display is accessible with the "SETUP" key.

```
                instrument setup
MAG SETUP■   ->menu        AUTO ST.INC.: no
                           CYCLE REPEAT: no


                           ERASE MEMORY: no
                           HEATER:       no
Chg?: ENT.                          BATT:119
```

Figure 25 SMARTMAG instrument setup display

Parameter	Description	Default
MAG SETUP	Displays the magnetometer specific setup menu. Pressing the "ENTER" key gets the next menu.	
AUTO ST.INC.	A "yes/no" toggle that controls the automatic station increment (decrement). no for the base station, walking or manual type of operation. yes for semi-automatic operation.	no
CYCLE REPEAT	Determines whether the magnetometer will take one reading only, or will continuously take readings at the time interval specified by the DURATION parameter in the Mag. Setup. This is **not** applicable for Base Station operation, which is set in the Mag Setup.	no
ERASE MEMORY	Allows clearing of the data memory. A request for confirmation will be displayed before the actual erasure takes place. NOTE: The setup parameters remain intact.	no
HEATER	Enables or disables the LCD display heater. If the temperature is above -15 degree C, enabling this parameter has no effect.	no

Magnetometer setup display

This display provides access to the parameters affecting the operation of the magnetometer portion of the SMARTMAG. This display is accessible from either the Instrument setup display, or from the Main operating display (by using the *short-cut*, i.e. pressing the "ENTER" key).

```
                mag setup
MODE:           t-fld      CYCLE TIME:   0
RATE:               5      CHART SCALE:100
BW:             8 Hz       BASE FIELD:50000
LOCAL FLD.:    50000       TIE-MODE:  line
BASE CORRECT:     no       AUTO RECORD:yes
TIE CORRECT:      no       HEM:N PITCH:100
Chg?:ENT.          help: INFO   BATT:b119
```

Figure 26 Magnetometer setup display.

Parameter	Description	Default
MODE:	Allows the selection of: ▲ Total Field Magnetometer (*default*) ▲ Gradiometer ▲ Base Station ▲ Off (will disable the SMARTMAG).	t-fld
RATE:	This is the sample rate (per second) of the audio output:	5
BW:	Bandwidth. Bandwidth and sample rates are independent — data may be obtained at the highest sample rate regardless of the bandwidth setting. You have a choice of 0.5, 1, 2, 4 or 8 Hz (or optionally higher frequencies).	8 Hz
LOCAL FLD.:	The value of the Earth's ambient magnetic field in the survey area. For best performance, the local field should match the ambient field as closely as possible, at least to within ±10,000 nT.	0

Parameter	Description	Default
BASE CORRECT:	A "yes/no" toggle that applies a BASE-STATION correction using data supplied from a base-station SMARTMAG. You must press the "+" key to toggle the yes on. You need to have the base-station connected as described in "Base-station operation" on page A8–11. A request for confirmation will be displayed in a pop-up window before your data is corrected. You must press the "9/YZ" (Yes) key to begin or the "5/MNO" (No) key to abort. NOTE: The original raw data is changed.	no
TIE CORRECT:	A "yes/no" toggle that applies a tie-point correction using data collected in the TIE mode. Selecting this opens a window indicating which tie-point (loop or line) correction mode is in effect. You must enter "Y" to start the correction. NOTE: The original raw data is changed.	no
CYCLE TIME:	The reading interval of the base station. The allowable range is 0 to 9999 seconds. Entering 0 (zero) results in a reading interval equal to the reading time. The instrument goes to "sleep" between readings, for 4 seconds and up.	0
CHART SCALE:	This function enables you to set the scale of the graphical diaplay chart	100

Parameter	Description	Default
BASE FIELD:	The base field is used in conjunction with the *base-station correction* procedure. The base-station correction technique removes variation in the ambient field during the time that the base station is running. However, variations taking place from day to day are not corrected. The base field value is used for this purpose. The actual value is not critical, as long as it is the same for all instruments in the survey. It is important that this value not be changed during the entire survey. A logical value is the first reading of the base-station on the first survey day.	0
TIE MODE:	Allows to select either the Line or Loop type of tie-line correction. Note: The Tie-line correction method is substantially *less precise* than the base-station correction method.	line
AUTO RECORD:	A "yes/no" toggle. This function is used in the semi-automatic mode to save you from having to press another key. Auto Record is always in effect in the base-station operation *or* if the Cycle Repeat function is selected in the SMARTMAG Instrument Setup.	no
HHEM:	This sets the hemisphere function to either north or south: N=north, S=south	N
PITCH:	This is the audio headphone sensitivity. You can select in increments of 10 from 0 to 990. The default is set to 100.	100

ADVANCED MODE DATA DISPLAYS

Data is displayed on a page by page basis in either numeric or graphic form. There are up to three pages each. The “NUM/GRA” key toggles between the two display forms.

Numeric data display

Numeric displays are only available when the instrument is recording data, i.e. you cannot “recall” the data in a tabular format as shown below.

The displays shown in the examples below are the numeric data displays for the total field, base station and gradiometer. Note that the noise is not available in the gradiometer display.

The total-field and the base-station displays do not differ.

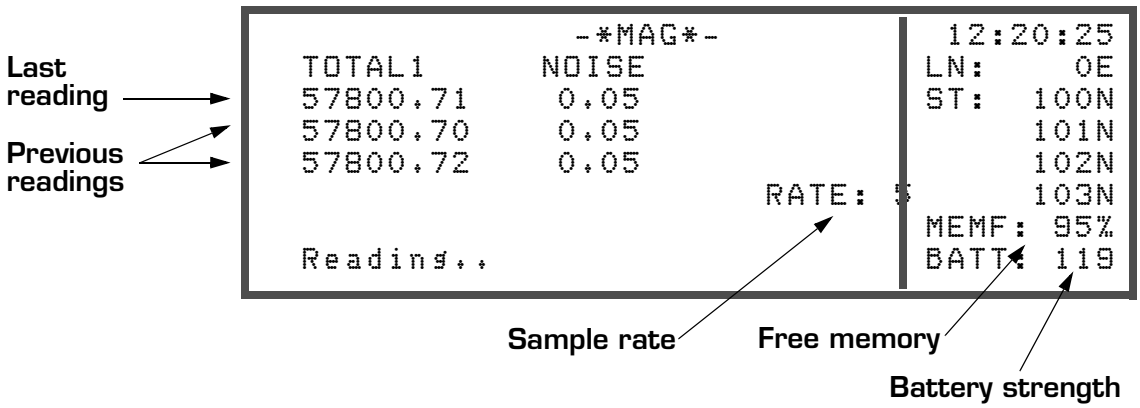


Figure 27 The numeric data display for total field and base station.

```
                -*MAG*-                    hh:mm:ss
TOTAL1     TOTAL2      GRADIENT            LN:11111d
mmmmm.m    mmmmm.m     g g g g g.g         ST:sssssd
mmmmm.m    mmmmm.m     g g g g g.g            sssssd
mmmmm.m    mmmmm.m     g g g g g.g            sssssd
mmmmm.m    mmmmm.m     g g g g g.g            sssssd
                                          MEMF: nn%
                                          BATT: bbb
```

Display Item	Description
TOTAL1	The magnitude measured by the first total-field sensor in nanoTeslas (nT). The most current reading is the *top* most followed by preceding readings.
TOTAL2	The magnitude measured by the second total-field sensor in nanoTeslas (nT). The most current reading is the *top* most followed by preceding readings.
NOISE	A number indicating the quality of the survey and individual readings. It is the fourth digital difference calculation done on consecutive readings. It is useful for determining overall noise and noise spikes.
GRADIENT	The magnetic gradient between the two sensors. Expressed in nT/m = (TOTAL 1 - TOTAL 2)/SEP, where SEP is the sensor separation in metres.
TIME	The current time in hours:minutes:seconds. It is used to time stamp each reading.
LN	The line number on which this measurement took place. The value consists of the numeric and directional parts.
ST	The station number to which the respective magnetic data applies. The value consists of the numeric and directional parts.
MEMF	The percentage of free memory. Measurements can be made when the memory is full, however the data is no longer recorded.
BATT	The voltage of the main battery. The normal range is between 100 and approximately 140 when the charger is connected. The instrument may turn off without warning when the value drops below 100 and will not allow more measurements. The data however still remains intact in memory as long as the main battery remains connected.

Graphic data display

If you are in the numeric data display, press 4 to access the graphic data display. Then press either 2 or 3 to access different pages.

The display shown below is page three of the graphic data for the gradiometer. Page one and two appears identical, except that the word "GRADIENT" is changed to either "TOTAL 1" or "TOTAL 2" and a plot of the respective total field is shown.

The graphic displays are available while reading. Use the scroll keys to select different graphic pages.

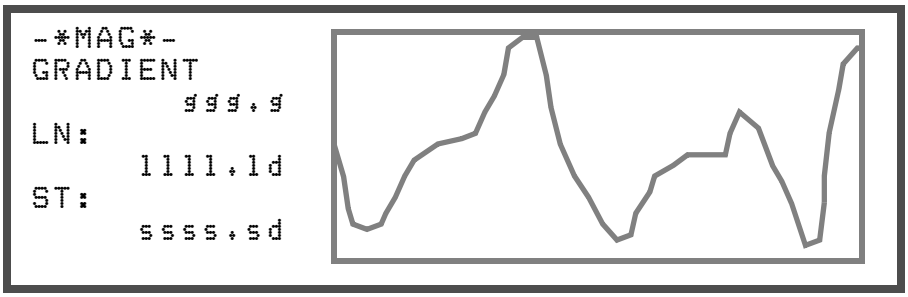


Figure 28 Graphic data display of page 3.

Display Item	Description
GRADIENT	The display title indicating the data shown by the graph. The numeric value indicated by ggg.gg is the respective gradient, at the indicated Line and Station number.
LN	The line number along which this measurement took place (consisting of the numeric and directional parts).
ST	The station number, at the cursor position, to which the respective magnetic data applies (consisting of the numeric and directional parts).

RECALL DISPLAYS

The "RECALL" function is useful to view the collected and stored data.

Recall setup display

This display allows you to select the type, location or time and date of the data. This display is accessed by pressing the "RECALL" key.

Figure 29 The recall setup display.

Display Item	Description
MAG	The mode of the data collected. Either one of Total Field, Gradient or Base Station.
LN	The line number whose data is to be recalled, consisting of the numeric and directional parts.
ST	The station number is the starting location for the recall, consisting of the numeric and directional parts.
TM	The starting time of the recall. This parameter is only present when the Base Station is selected.
DT	The date of the data to be recalled. This parameter is only present when the Base Station is selected.

Display Item	Description
BATT	The voltage of the main battery. The normal range is between 100 and approximately 140 when the charger is connected. The instrument may turn off without warning when the value drops below 100 and will not allow more measurements. The data however still remains intact in memory as long as the main battery remains connected.

Note: Not only the Time and Date, but the Line and Station numbers must also be correct to successfully recall Base Station data.

Recall data display

Data can be recalled only in *graphic* form. Up to 178 readings can be shown at one time. The display window can be moved sideways (called *panning)* in steps of one half of its width (i.e. up to 89 readings) to view adjacent data with the aid of the "+" or "–" keys. It is also possible to adjust the vertical scale and bring any point to the vertical center of the window.

Exact values can be read off the numerical section at the left hand side of the display.

The Total Field display is shown and explained. The Gradient display differs in title only. The Base Station display shows Time and Date instead of Line and Station. Note that there are *two* pages of data for the gradiometer.

These displays are accessible with the "START" key when in the Recall Setup display.

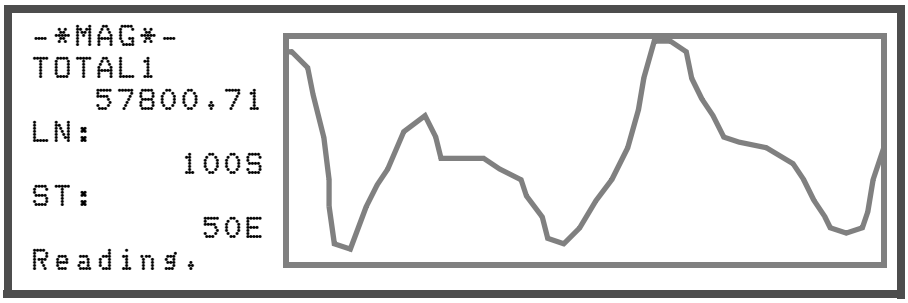


Figure 30 The recall data display.

Display Item	Description
TOTAL	The title of the display indicating the data shown by the graph. The numeric value indicated by mmmmm.mm is the respective total-field value, at the indicated line and station number. The scroll keys may be used to view alternate pages.
LN	The line number along which this measurement took place, consisting of the numeric and directional parts.
ST	The station number to which the respective magnetic data applies, consisting of the numeric and directional parts, at the *cursor position*. See the next page for more on cursor position.

Modifying the display window

The graph can be altered by changing the vertical scale or by centering any point vertically in the window. A smaller window can be opened up using the “ENTER” key to allow changes. The changes take effect after you next press “ENTER.”

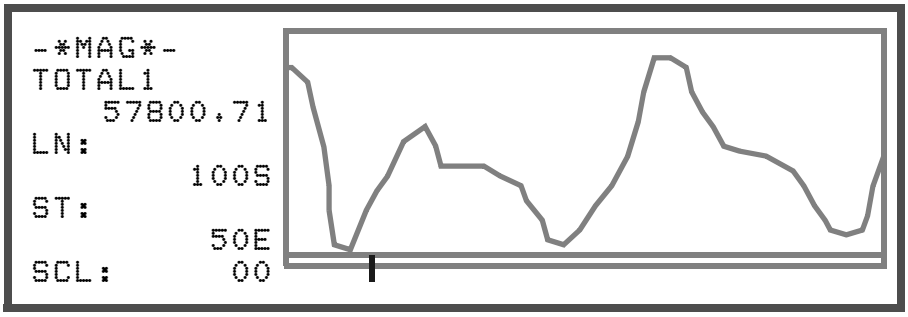


Figure 31 The Recall display ready for customizing

Display Item	Description
SCL	Shown after the "ENTER" key is pressed. It indicates the vertical full scale. Scrolling using the +/– keys allows the full scale values of 1, 10, 100, 1000, or 10,000 nT.
	This is the cursor, which is normally at the left edge of the window. It can be moved with the aid of the ←, → cursor keys. Numerical data at the left hand side of the display represents the data at the cursor position.

Pressing the “0” key adjusts the display such that the point at the cursor position becomes the center value of the graph.

AUXILIARY DISPLAY

The Auxiliary display is accessible by pressing the "AUX/LCD" key. It provides additional functions which are not directly accessible from the keyboard. You will need to press the appropriate key to get to the function.

```
          auxiliary functions

          (+- ESC)  LCD Intensity
          (1)       Data Output
          (2)       Factory Test *    0
          (3)       Lock              OFF
          (4)       Reprogram System
Select function
```

Figure 32 The auxiliary functions display.

Key pressed	Action under: auxiliary functions
	These keys allow you to adjust the intensity of the LCD screen for better viewing under a variety of lighting conditions.
	This option allows you to access the Data Output menu to transfer information to your computer or printer.
	This function is reserved for production and service tests. It has no functions for you to use.
	The lock option allows you to lock the SMARTMAG setup parameters so that they are not accidentally changed. To make any changes, you will have to toggle this option first.
	This option allows you to update your SMARTMAG's EPROM with more functionality. The software is supplied by SCINTREX.

DATA OUTPUT DISPLAY

This display allows the selection of:

- ▲ communication parameters between the SMARTMAG and the output device such as a computer or printer,
- ▲ the data format of the output,
- ▲ and possibly the Line number, if a line by line data dump is desired.

The data can be dumped in its entirety at once, or selectively on a mode basis.

This display is accessible from the Auxiliary display.

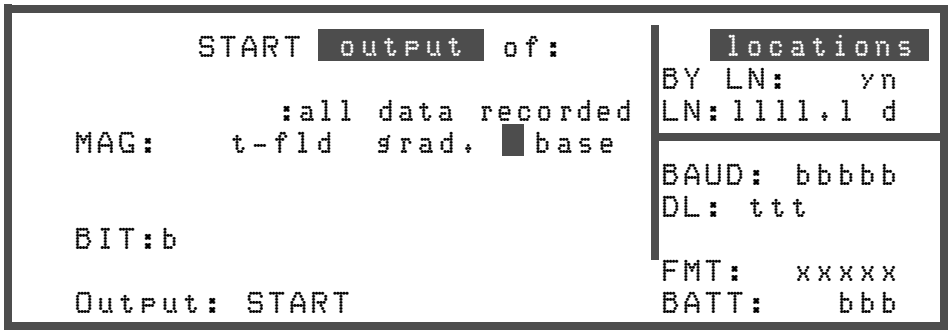


Figure 33 The data output display.

Parameter	Description	Default
: all data recorded	With the cursor placed after the colon, all the data in the instrument would be dumped sequentially into one, possibly very large file.	
MAG	Lists the modes available for the SMARTMAG. As shown, only the gradiometer data would be dumped as indicated by the cursor position	

Parameter	Description	Default
BY LN	yes/no Directs the instrument to dump the data on a line by line basis, in addition to a method by method basis. This is usually left at no.	no
LN	The line number whose data has to be dumped, consisting of the numeric and directional parts.	
BAUD	The baud rate of communication with the output device. The following choices are available by scrolling: 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 baud.	9600
DL	A delay which may be added after each carriage return/linefeed (CR/LF) to accommodate slow peripherals such as some printers. The range is 0 to 999 ms. This value is normally left at 0 for dumping to computers. The proper setting has to be established experimentally for other equipment. Problems usually are indicated by the loss of a few characters.	0
BIT	The number of data bits. The default value is 8 bits, which usually works properly. The proper setting has to be established experimentally. For example, on some EPSON printers, 7 or 8 bits results in either normal or italic print.	8
FMT	The output data format. The formats are described briefly in the following table on page A6–38.	

Parameter	Description	Default
BY LN	yes/no Directs the instrument to dump the data on a line by line basis, in addition to a method by method basis. This is usually left at no.	no
LN	The line number whose data has to be dumped, consisting of the numeric and directional parts.	
BAUD	The baud rate of communication with the output device. The following choices are available by scrolling: 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 baud.	9600
DL	A delay which may be added after each carriage return/linefeed (CR/LF) to accommodate slow peripherals such as some printers. The range is 0 to 999 ms. This value is normally left at 0 for dumping to computers. The proper setting has to be established experimentally for other equipment. Problems usually are indicated by the loss of a few characters.	0
BIT	The number of data bits. The default value is 8 bits, which usually works properly. The proper setting has to be established experimentally. For example, on some EPSON printers, 7 or 8 bits results in either normal or italic print.	8
FMT	The output data format. The formats are described briefly in the following table on page A6–38.	

Parameter	Description	Default
BY LN	yes/no Directs the instrument to dump the data on a line by line basis, in addition to a method by method basis. This is usually left at no.	no
LN	The line number whose data has to be dumped, consisting of the numeric and directional parts.	
BAUD	The baud rate of communication with the output device. The following choices are available by scrolling: 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 baud.	9600
DL	A delay which may be added after each carriage return/linefeed (CR/LF) to accommodate slow peripherals such as some printers. The range is 0 to 999 ms. This value is normally left at 0 for dumping to computers. The proper setting has to be established experimentally for other equipment. Problems usually are indicated by the loss of a few characters.	0
BIT	The number of data bits. The default value is 8 bits, which usually works properly. The proper setting has to be established experimentally. For example, on some EPSON printers, 7 or 8 bits results in either normal or italic print.	8
FMT	The output data format. The formats are described briefly in the following table on page A6–38.	

Parameter	Description	Default
BATT	The voltage of the main battery. The normal range is between 100 and approximately 140 when the charger is connected. The instrument may turn off without warning when the value drops below 100 and will not allow more measurements. The data however still remains intact in memory as long as the main battery remains connected.	

Data output formats

The following table shows the available output formats for dumping the data to a computer or printer:

Data output format	Description
XYZ	XYZ is the simplest format, suitable for software packages such as ENVIMAP. It contains no heading or comments. The individual data items are separated by a single space character. X and Y represent the cartesian coordinates (N and E are positive, while S and W are negative). Z is one or more items of magnetic data. There is one set of data per printed line, including the time of the measurement. CAUTION: Due to the lack of header information, you should label the files clearly.
XYZ+	XYZ+ is identical to XYZ, but a header and user entered NOTES are added.
XYZ++	XYZ++ is identical to XYZ+, but the data is now placed into columns.
PRN	PRN is a format used with software for the SCINTREX MP-3/4 Magnetometer.
NOTES	NOTES outputs a report of all user entered NOTES, cross-referenced with the Line and Station number.
BINARY	Outputs all data in compact binary format (non-ascii). Requires the DOS program BINDUMP to receive the binary data. The binary file created by BINDUMP may then be converted into any of the above formats by the DOS program XFSMART* *BINDUMP and XFSMART are supplied with the SMARTMAG

NOTES DISPLAY

The notes display is useful for the entry of comments, which are stored with the data at the particular Line and Station number.

Macros (pre-recorded messages) provide a quick entry for repetitive notes which can be entered while measuring. This display is accessible with the “NOTE” key.

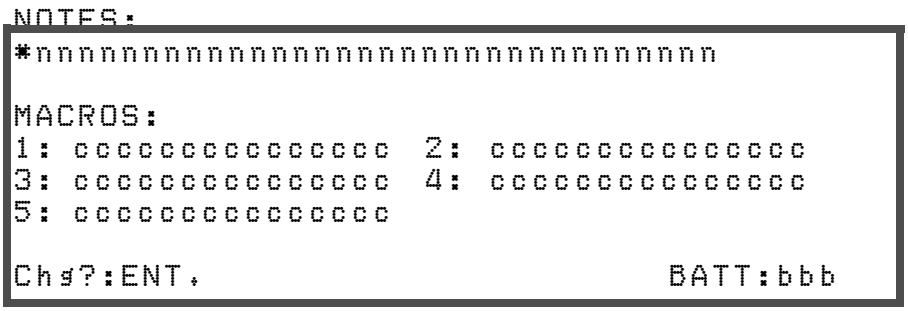


Figure 34 The NOTES display.

Parameter	Description
NOTES	Alpha-numeric characters, including "+", "." and "–", up to 32 characters A note can be saved as one of five macros in a separate memory for re-use.
MACROS 1: ... 5:	MACROS are pre-recorded messages of up to 15 characters. These are used to speed up note entry. It is most advantageous to enter frequently encountered items, such as *road*, *fence*, and so on.

Parameter	Description
BATT	The voltage of the main battery. The normal range is between 100 and approximately 140 when the charger is connected. The instrument may turn off without warning when the value drops below 100 and will not allow more measurements. The data however still remains intact in memory as long as the main battery remains connected.

INFORMATION DISPLAY

This display screen is used for the entry of ancillary information. You can also see how much free memory is available. This screen is accessed from the main display by pressing the “INFO” key.

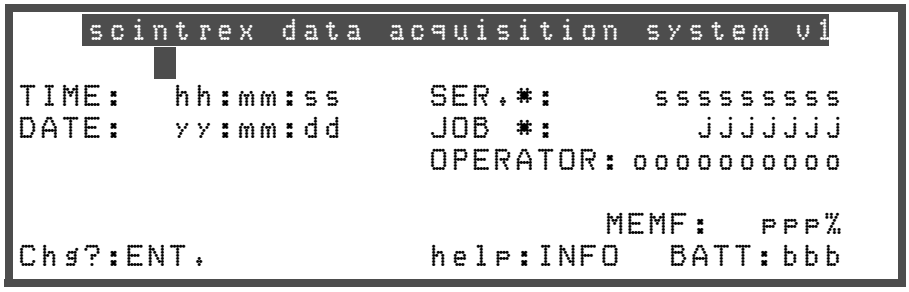


Figure 35 The INFO display.

Parameter	Description
Vx.x	The version number of the SMARTMAG internal software.
TIME	The current time of day.
DATE	The present date.
SER.*	This is usually the serial number of the instrument. No use is made of this number by the instrument, therefore it also could represent the users inventory number. Up to 8 digits are accepted.
JOB *	This may be the survey project number. Up to 6 digits are accepted.
OPERATOR	This is the operator's name or number. It can contain up to 10 characters.
MEMF	The percentage of free memory available for further use.
BATT	The voltage of the main battery. The normal range is between 100 and approximately 140 when the charger is connected. The instrument may turn off without warning when the value drops below 100 and will not allow more measurements. The data however still remains intact in memory as long as the main battery remains connected.

Warning: The TIME and DATE *must* match between the base-station and the portable magnetometer(s) for the base-station style of correction to work properly.

SMARTMAG DISTANCE TRIGGER

The SMARTMAG console external distance trigger is used in the WALK-MAG mode in areas where no survey grid was placed ahead of time. The external trigger does not trigger a reading, but it triggers an increment in the station number by the station separation in the same manner as the NEXT key does.

The external trigger can be a measuring wheel or hip chain equipped with a normally open switch. A new menu item under '`locations`' called '`DIVBY`' is used to count trigger switch closures. If `DIVBY` is set to 150 for example, then the station will be incremented by the station separation after 150 switch closures of the external trigger switch. Set `DIVBY` to zero when not using the external trigger.

If the operator presses the NEXT key when using the external trigger, the station will increment by the station separation as usual, but this resets the trigger switch counter. The trigger switch counter will be reset whenever the NEXT key is depressed — no matter what menu you are in. So if you stop surveying in the middle of the count, and expect the counter to continue where it was after you restart — do not press the NEXT key.

If you are using a wheel, trigger switch closures should take place at 25 to 60 cm intervals, which means that a number of switch closures should take place per revolution of the wheel. The reason for this is to reduce the ambiguity at the start of the line.

Set `DIVBY` by the following formula:

DIVBY = (SEP/C) x **n** (wheel method)

DIVBY = (SEP/d) (hip chain method)

where: **SEP** is the station separation
C is the circumference of the wheel
n is the number of switch closures per revolution
d is the contact spacing of the hip chain

The station separation must be chosen as some multiple of the circumference of the wheel (if used).

For efficiency of memory usage, it is recommended that at least 25 readings take place in the time it takes to traverse the station separation. This rule of thumb then allows you to determine a minimum station separation:

minSEP = (25/rate) x **speed**

where: **minSEP** is the minimum station separation
rate is the number of sample per second
speed is the walking speed

So at 5 samples per second and a walking speed of 0.5 metres per second, the following minimum station separation is recommended:

minSEP = (25/5) x 0.5 = 2.5 metres

Of course, if a wheel is being used, the station separation must be a multiple of the wheel circumference and it must be greater than the minimum separation. For our example above (**minSEP** of 2.5 metres), if a one metre wheel is used, then **SEP** must be at least 3.0 metres, since 3.0 is the first multiple of 1.0 metre greater than 2.5 metres.

Chapter 7

SETTING-UP THE SMARTMAG CONSOLE

This chapter describes the process of how to:

- initialize the SMARTMAG console for first time operation,
- program it for the different modes of operation,
- enter line and station numbers.

Step by step procedures are given in Chapter 8 on how to perform:

- a total-field survey in the WALKMAG mode (basic),
- a gradiometer survey in the stop-and-go mode (advanced),
- base-station operation (advanced).

FIRST TIME OPERATION

A special procedure has to be followed to get the SMARTMAG software set up properly. This procedure is called a *cold boot*. This assures that all setup parameters are initialized properly and that the memory is cleared.

Caution: First time operation procedures (*cold boot*) have to be carried out every time the instrument has had its battery disconnected for more than 10 minutes. You may also need to cold boot if the screen stays blank or is scrambled.

COLD BOOT

To perform a cold boot, proceed as follows:

1. Press the "ON/OFF" key repeatedly and listen carefully to the beeper. Stop pressing the key after the display goes blank, or after the unit stops beeping. This is to ensure that the SMARTMAG is truly in the *OFF* state.

2. **Press** and **hold** the "AUX/LCD" key. Then press the "ON" key. Release both keys after the beep. The following message should appear:

```
COLD BOOT (Y/N)?
WARNING !

Setup parameters / data will be
erased
```

3. **Press** the "9/YZ" key containing "Y" for *yes* to confirm the cold boot operation.

4. You are now ready to set-up your SMARTMAG for surveying.

Note: The default configuration is the advanced mode (configurations 5 to 7), after a cold boot.

CONFIGURATION MENU

The SMARTMAG has seven pre-defined configurations in three modes to choose from. See “Pre-defined operating modes” on page 6–1. To change your configuration at any time:

1. Press the “SETUP” and “ON” keys simultaneously.

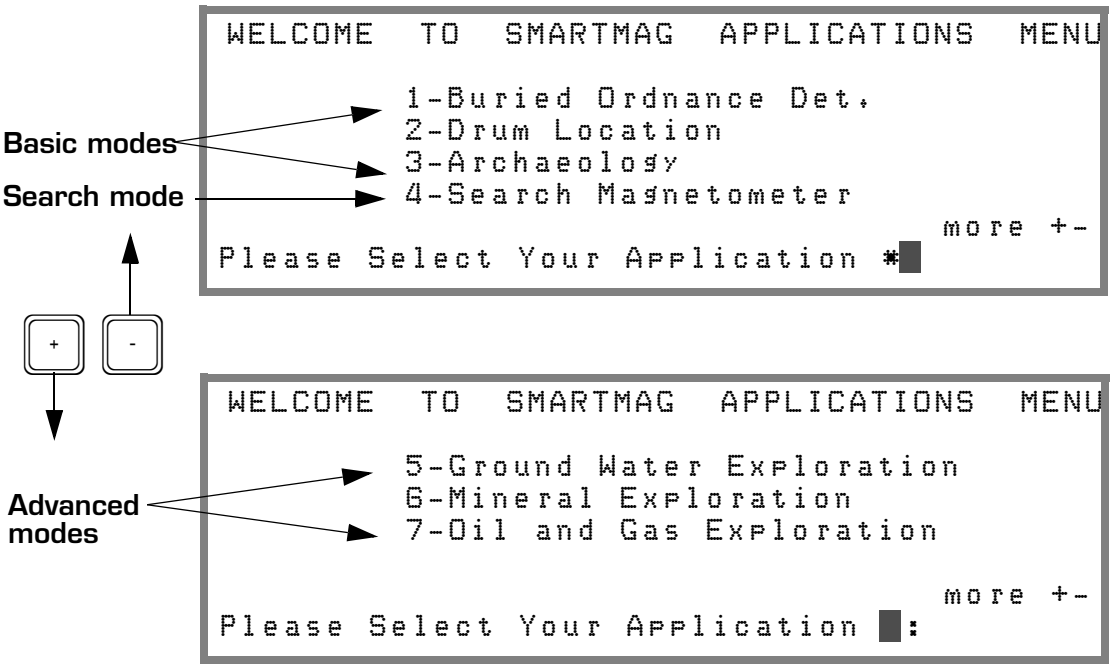


Figure 36 SMARTMAG configuration menus

2. To see the other menu display, press either the “+” or “–” keys.

3. Select the appropriate configuration for the type of survey you wish to perform, by pressing the corresponding numeric key, i.e. “1” to “7”. This configuration can be changed at anytime by repeating step 1.

GENERAL SETUP PRINCIPLES

Setting up the SMARTMAG consists of:

- ▲ bringing up the various display screens,
- ▲ moving the cursor to different parameter fields,
- ▲ then either selecting from a list, or entering appropriate values.

It is assumed that you have performed a configuration selection and have one of the following three Main operating displays:

```
MODE: t-fld S,SEP:0,5m     locations
BW:                 8 Hz
PITCH:               100   ST:      10, E
LOCAL FLD,:        50000   SEP:        0,
TM/DT:    OUTPUT:          DIVBY:      0,
BASE:     TIE:             LN:       1, N
HEM:N ERASE MEM,:          SEP:       10,
Chg?:ENT,          help:INFO      BATT:119
```

Note: S,SEP is used only in the SM-4G model for gradiometer separation

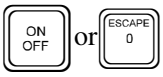
```
MODE:          srch,
BW:             8 Hz
PITCH:           100
LOCAL FLD:     50000


HEM:N
Chg?:ENT,          help:INFO      BATT:119
```

```
       START measurement   of: locations

MAG:          mmmm             ST:    sss,s d
                               SEP:    pppp,p
                               DIVBY:      0,
                               LN:   llll,l d
                               SEP:    pppp,p
Measure:START            ALL Keys  BATT:bbb
```

Figure 37 Main operating displays for all modes

HOW TO:

ACCESS THE MAIN OPERATING DISPLAY



The main operating display can be called up by simply pressing the "ON" key *or* by pressing the "ESCAPE" key one or more times.

ACCESS DISPLAY SUB-PANELS/BLOCKS

Some display screens have sub-panels or blocks that are separated by a vertical and/or horizontal line. These represent different logical sub-groups of information. To move the cursor into another block, you will have to press the "NEXT" key.

ACCESS THE PARAMETER FIELDS

To access a particular parameter field, move the cursor by repeatedly pressing either of the cursor (← →) keys until the cursor is on the desired field.

CHANGE PARAMETERS

There are two types of parameters—those that are selected from a *list* and those that you must *fill-in* a value. The proper method for changing a particular item is indicated by the *prompt* at the left-hand, bottom corner of the display.

Changing the parameters requires you to either:

▲ select from a list when the prompt is `Chg?+-`, by pressing either the "+" or "–" keys. Please see also "Select!" on page 7–6.

or

▲ fill in the parameter fields via the keypad when the prompt is `Chg?ENT`, by first pressing the "ENTER" key. You will then need to follow the procedures as described for "Enter!" on page 7–6.

SELECT! AND ENTER!

To simplify the detailed descriptions that will be presented next, the keywords **Select!** and **Enter!** will be used to represent a series of actions that you will be required to do. These are defined as follows:

Select!

When the prompt `Chg?:+-` appears in the bottom left corner of the display, you have a *pre-defined* list of values to choose from. You will be required to make a selection as follows:

Press either the "+" or "–" key to scroll through two or more parameters.

Enter!

When the prompt `Chg?:ENT.` appears in the bottom left corner, the parameter field requires you to enter a specific value. To enter values, you will be required to do the following:

Step	PRESS	Action
1	ENTER RATE	This opens the field for data entry as indicated by a new prompt (>) at the start of the field.
2	AUX/LCD 1 ABC to RECALL 9 YZ	Key in the desired value. If the field requires a *numeric* input, just press the appropriate keys in sequence. If the field requires *alphanumeric* input, you may need to press the same key several times to get the proper character to appear. If you enter an incorrect value, use the "CLEAR" key to delete the incorrect character(s). (For more information on editing an entry, please refer to "Note entry" on page 7–23.)
3	ENTER RATE	Pressing the "ENTER" key again stores the value in memory and the prompt (>) disappears.

LINE AND STATION SETUP

For the basic and advanced modes, you will need to enter into the SMARTMAG the information about your survey grid. This includes:

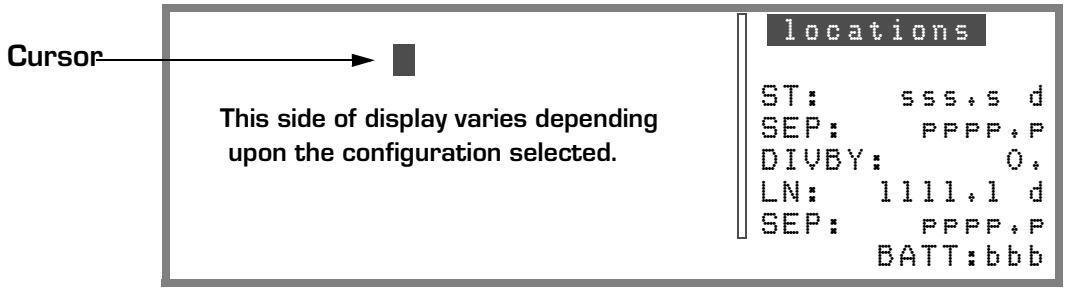
- your starting points on each line,
- how far apart each line is,
- how far apart each station on the survey line is.

In considering the co-ordinate system shorthand you will be using for a survey grid, you need to know that the units of measure are not important, as no calculations are made with respect to distance. Consequently, you can use single digits to represent values that may actually be in hundreds. Please also refer to the *Applications* booklet for more details on survey grids.

To show you the steps required to set the line station values, the following example will:

- set the Line Number (LN) to Line 16 East (sometimes marked as 16+00E) with a Line separation (SEP) of 2,
- set the Station Number (ST) to 50 North (sometimes marked as 50+00N), with a Station separation (SEP) of *minus* 10. The *minus* indicates that the walking direction is to the south.

From either Main operating display, proceed as follows:



1. **Press** the "NEXT" key to move the cursor to the right hand block/ sub-page of the display. If the cursor is already in the `locations` block, go on to the next step.

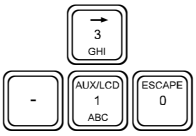
ENTERING THE STARTING STATION

2. Move the cursor to `ST:`

3. **Enter!** `50`.

4. Move the cursor one step forward.

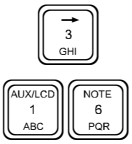
5. **Enter!** `n` (for north).



6. Move the cursor to `SEP:`

7. **Enter!** `-10`. *Note*: The '–' causes the station number to *decrement*. This indicates that you will be travelling south and that stations are spaced 10 units apart).

ENTERING THE STARTING LINE



8. Move the cursor to `LN:`

9. **Enter!** `16`

10. Move the cursor one step forward.

11. **Enter!** `e` (for east)

12. Move the cursor to `SEP:`

13. **Enter!** `2` (This indicates that you will be surveying successive lines 2 units apart and you will be moving in a easterly direction.)

To set your required starting point and separations, just substitute your specific values in the previous steps. Also, keep in mind that entering *negative* values for the separation parameters causes the respective line or station values to *decrement*.

BASIC MODE

The basic mode consists of configurations 1 to 3:

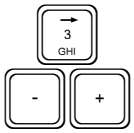
```
1. Buried Ordnance Det.
2. Drum Location
3. Archaeology
```

These configurations require minimal setup and are set for:

- ▲ WALKMAG (continuous reading) type of survey,
- ▲ base-station or tie-point *Loop* mode data correction only,
- ▲ fixed output at 9600 baud with a XYZ++ format.

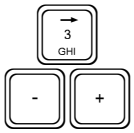
SAMPLE TOTAL-FIELD SETUP

```
MODE:t-fld S.SEP:0.5m     | locations
BW:                 8Hz   |
PITCH:              100   | ST:      10. E
LOCAL FLD.:               | SEP:       25.
TM/DT:    OUTPUT:         | DIVBY:      0.
BASE:     TIE:            | LN:       1. N
HEM:N ERASE MEM.:         | SEP:       10.
Chg?:ENT.        help:INFO |      BATT:119
```



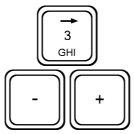
1. Move the cursor to `MODE:`

2. **Select!** `tfld` from the list of `tfld`, `grad`, `base:`



3. Move the cursor to `S.SEP:`

4. **Select!** `0.5m` from the following list: 0.5m, 1.0m or 1.5m. The separation is the distance between the gradiometer sensors. This parameter is only for the gradiometer version (SM–4G).



5. Move the cursor to `BW:`

6. **Select!** `8 Hz` from the following list: `0.5`, `2`, `4`, `8` Hz (or optionally higher frequencies).

7. Move the cursor to `PITCH:`

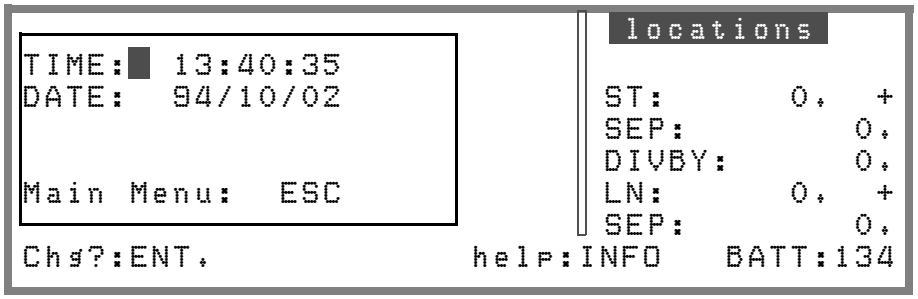
8. **Select!** 100 from the list of: 10 to 990 in increments of 10.

9. Move the cursor to `LOCAL FIELD:`

10. **Enter!** `60000` (or an appropriate value for your survey area).

11. Move the cursor to `TM/DT:`

12. Press the "ENTER" key and window for the date and time values will pop-up on the right-hand side of the display.



13. **Enter!** the time and date (following steps 2 to 13 on page 7–21).

Warning: If you are using a base-station, please make sure that the time and date are the same as your field unit. If the time is out, the corrections will be incorrectly applied. If the date is wrong, no corrections can be performed at all.

14. Move the cursor to `HEM:`.

15. Select '`N`' if you are in the Northern Hemisphere, or '`S`' if you are in the Southern Hemisphere. (Note, if you select the wrong hemisphere, the noise readings in the Numeric display will be higher than for the correct hemisphere selection.)

16. Enter your survey grid values as described in"Line and Station setup" on page 7–7.

You are now ready to start surveying.

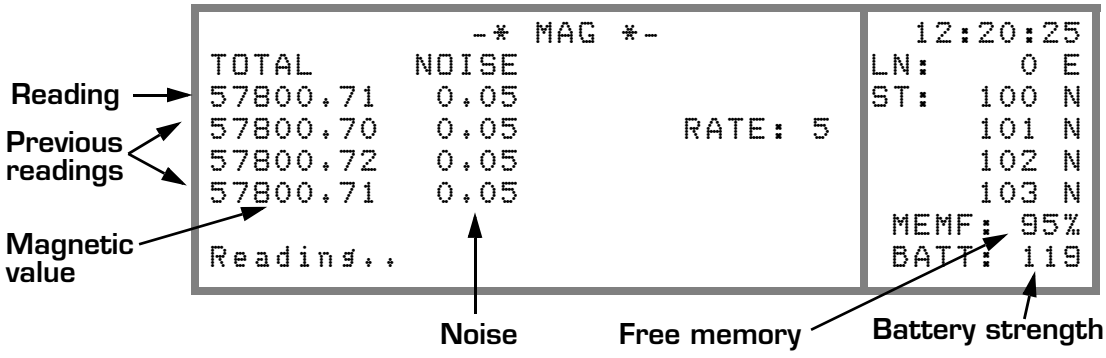
STARTING YOUR SURVEY

1. Press the "START" key. The display will read '`Initializing`'.

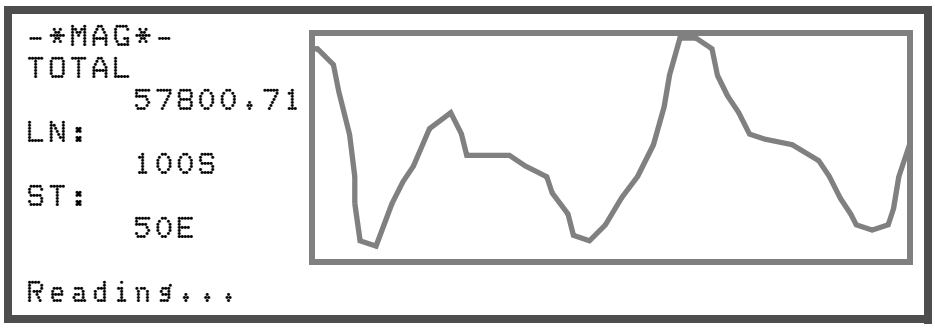
Note: If your display reads '`Communication problem`', during initialization, check the RS-232 connection between the sensor staff and the console.

2. When the initialization is complete, you will enter the Numeric Display. You can change the sample rate by pressing the "ENTER" key and selecting the appropriate sample rate.

The Display screen during data collection is as follows:



You can switch to the Graphic Display by pressing the NUM/GRAPH key. This display is shown below:



SEARCH MODE

The search mode is obtained by selecting configuration `4-Search Magnetometer` from the SMARTMAG Applications menu (after pressing the "SETUP" and "ON" keys simultaneously).

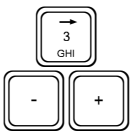
This mode does not store any data (that you can dump) in memory, but you can see a graphical representation of up to the last 178 readings. This mode is useful for rapid reconnaissance or location of magnetic objects in small areas where no permanent record of the data is required.

There are only two parameters that need to be set for this mode— the bandwidth (BW) of the reading and the local (ambient) field value.

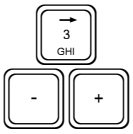
Note: This mode does not support gradiometer operation.

SAMPLE SEARCH MODE SETUP

```
MODE:          srch.
BW:             8 Hz
PITCH:           100
LOCAL FLD:     50000


HEM:N
Chg?:ENT.         help:INFO        BATT:119
```



1. Move the cursor to `BW:`.
2. **Select!** `8` from the following list: 0.5, 2, 4 or 8 Hz.



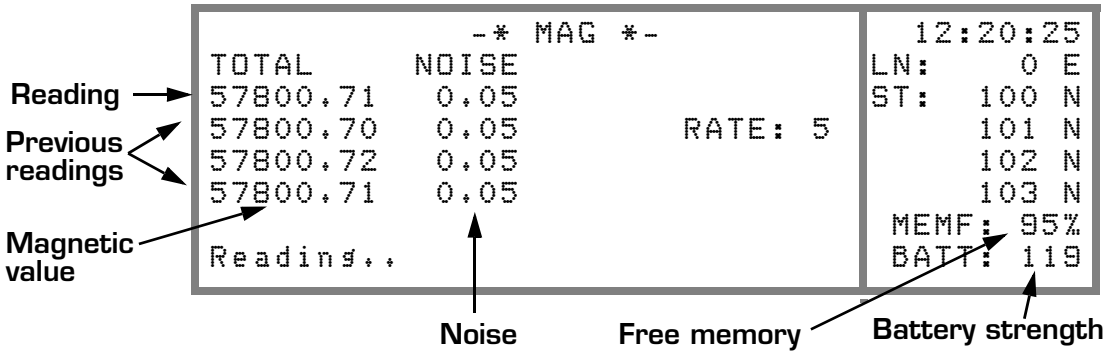
3. Move the cursor to `PITCH:`.
4. **Select!** `100` from the following list: 10 through 990 in increments of 10.

5. Move the cursor to `LOCAL FLD:`.

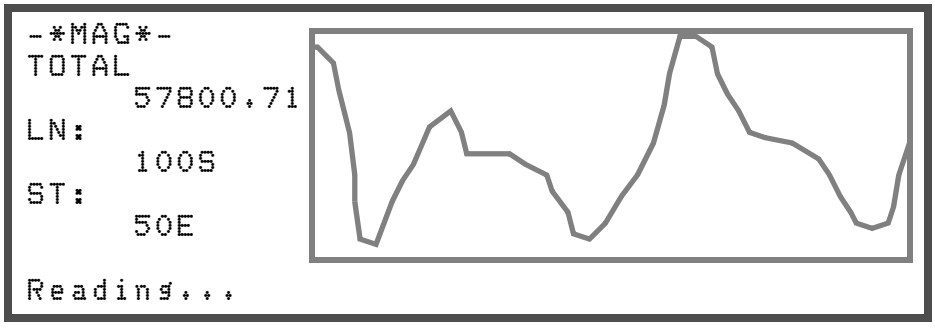
6. **Enter!** `50000`.

You are now ready to start looking for magnetic objects.

The display screen during data collection is as follows:



You can switch to the Graphic Display by pressing the NUM/GRAPH key. This display is shown below:



ADVANCED MODE

The SMARTMAG setup in the advanced mode, initializes parameters which are common to all three of the exploration (ground water, mineral, and oil & gas) configurations installed. This mode gives you *total control* over all the parameters of the SMARTMAG. You can also use this mode to run the types of surveys defined in the Basic mode, with the additional benefit of more features being available. Several examples will be given to show you how to setup:

- ▲ the instrument operating details (how long and how often a reading is taken),
- ▲ a total-field WALKMAG and/or WALKGRAD survey,
- ▲ a gradiometer Stop-and-Go survey,
- ▲ a base-station operation,
- ▲ note entry,
- ▲ other auxiliary functions.

INSTRUMENT SETUP

The following setup prepares the instrument for a total-field or gradient survey in the WALKMAG or WALKGRAD modes respectively. This mode uses the cycle repeat feature of the measurement. A cycle delay can also be entered, so that the repetition rate is adjusted while walking uphill or downhill.

From the Main operating display proceed as follows:

1. **Press** the "SETUP" key.

   The INSTRUMENT SETUP display appears:

```
              instrument setup
MAG SETUP: ->menu        AUTO ST.INC.:no
                         CYCLE REPEAT:no

                         ERASE MEMORY:no
                         HEATER:no
Chg?:ENT.                BATT:119
```

2. Move the cursor to `AUTO ST.INC:` (automatic station increment).

3. **Select!** `no` (Since the SMARTMAG is reading continuously, you want the station value to change only when you reach a station—not with every reading!).

4. Move the cursor to `CYCLE REPEAT:`

5. **Select!** `yes`

6. Ignore `ERASE MEMORY:`

7. Move the cursor to `HEATER:`

8. **Select!** `no` (unless you are doing a winter survey and the ambient temperature is below minus 15° C.)

9. **Press** "ESCAPE" to return to the Main operating display.

SAMPLE TOTAL-FIELD SETUP (WALKMAG OR WALKGRAD)

The following steps prepare the SMARTMAG for:

- a total-field survey in the WALKMAG or WALKGRAD modes,
- with 0.2 second reading period, (5 readings/sec.),
- automatic tuning,
- manual station increment.

From the Main operating display proceed as follows:

1. **Press** the "SETUP" key and the INSTRUMENT SETUP display appears:

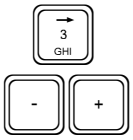
```
              instrument setup
MAG SETUP:  ->menu          AUTO ST.INC.:no
                            CYCLE REPEAT:no

                            ERASE MEMORY:no
                            HEATER:no
Chg?:ENT.                   BATT:119
```

2. Carry out steps **2** through **9** (as shown on 6page 7–15) for setting up the instrument, if you have not already done so.

3. Move the cursor to MAG SETUP.

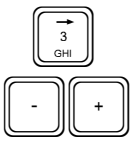
4. **Press** "ENTER" and the MAG SETUP display appears.

```
                 mag setup
MODE:         t-fld         CYCLE TIME:0
RATE:             5         SENSOR SEP:0.5m
BW:            8 Hz         BASE FIELD:50000
LOCAL FLD.: 50000           TIE-MODE:line
BASE CORRECT:  no           AUTO RECORD:yes
TIE CORRECT:   no           HEM:N PITCH100
Chg?:ENT.                   BATT:119
```



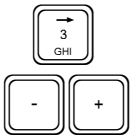
5. Move the cursor to MODE:.

6. **Select!** t-fld or grad from the following list: off t-fld gradbase.



7. Move the cursor to RATE:.

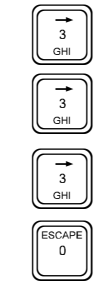
8. **Select!** 5 from the following list: 1, 2, 5 10 readings/sec.



9. Move cursor to BW:.

10. **Select!** 8 from the following list: 0.5, 1, 2, 4, 8 Hz (or optionally higher bandwidths).

11. Move the cursor to LOCAL FIELD:.



12. **Enter!** the ambient magnetic field value of your survey area.

13. Ignore `BASE CORRECT:`

14. Ignore `TIE CORRECT:`

15. Move the cursor to `CYCLE TIME:`

16. **Enter!** `0` (this parameter is used in the base-station mode only and should be `0` for all other modes).

17. Move the cursor to `SENSOR SEP:` (`Grad` mode only).

18. **Select!** `0.5`m from the following list: 1.0m and 1.5m.

19. Move the cursor to `BASE FIELD:`

20. **Enter!** the ambient magnetic field value, if known, of your survey area.You can also take a reading and enter the value.

21. Ignore `TIE-MODE:`

22. Move the cursor to `AUTO RECORD:`

23. **Select!** `no`

24. Move the cursor to `HEM:`.

25. **Select!** `N` or `S` depending on your survey area.

26. Move the cursor to `PITCH:`.

27. **Select!** `100` from the following list: 10 through 990 in increments of 10.

28. Press “ESCAPE” to return to the Main operating display.

SAMPLE BASE-STATION SETUP

The following steps prepare the SMARTMAG as a:

- ▲ magnetic base-station,
- ▲ with a 0.2 second reading period.

From the Main operating display proceed as follows:

1. **Press** the "SETUP" key and the INSTRUMENT SETUP display appears.

```
                instrument setup
MAG SETUP:■->menu        AUTO ST.INC.:yn
                         CYCLE REPEAT:no

                         ERASE MEMORY:no
                         HEATER:no
Chg?:ENT.                BATT:119
```

2. Follow the instructions for the Instrument setup, as shown on page 7–14, but substitute the following:

3. Move the cursor to `AUTO ST. INC:`.

4. **Select!** `no`

5. Move the cursor to `CYCLE REPEAT:`.

6. **Select!** `no`

7. Ignore `ERASE MEMORY:`.

8. Ignore `HEATER:` (unless you are doing a winter survey and the ambient temperature is below –15°C.

9. Move the cursor to `MAG SETUP:`.

10. Press ENTER to enter the MAG SETUP display.

The MAG SETUP display appears:

```
                mag setup
MODE:        t-fld      CYCLE TIME:0
RATE:            5      SENSOR SEP:0.5M
BW:           8 Hz      BASE FIELD:50000
LOCAL FLD.: 50000       TIE-MODE:line
BASE CORRECT:  no       AUTO RECORD:yes
TIE CORRECT:   no       HEM:N PITCH:100
Chg?:ENT.               BATT:119
```

11. Move the cursor to `MODE:`.

12. **Select!** `base`

13. Move the cursor to `RATE:`.

14. **Select!** `5` from the following list: 1, 2, 5, 10.

15. Move the cursor to `BW:`.

16. **Select!** `8` from the following list: 1, 2, 4, 8 Hz (or optionally higher frequencies)

17. Move the cursor to `LOCAL FLD.:`.

18. **Enter!** the ambient magnetic field value of the survey area. .

19. Ignore `TIE CORRECT:`.

20. Move the cursor to `CYCLE TIME:`.

21. Move the cursor to `SENSOR SEP.:` (`Grad` mode only).

22. **Select!** `0.5`m from the following list: 0.5, 1.0, 1.5m.

23. Move the cursor to `BASE FIELD:`.

24. **Enter!** the ambient magnetic field value of the survey area.

25. Ignore the `TIE MODE:`.

26. Move the cursor to `AUTO RECORD:`.

27. Select! `no`.

28. Move the cursor to `HEM:`.

29. Select! `N` or `S` depending on the area of your survey.

30. Move the cursor to `PITCH:`.

31. Select! `100` from the following list: `10` through `990` in increments of `10`.

32. Press "ESCAPE" to return to the Main operating display.

Notes: To record base station readings less frequently than once a second, set cycle time to a non-zero value. For example, if cycle time = 10, then a reading is recorded every 10 seconds.

The console will go to sleep between readings if cycle time is set to 5 or more seconds. In order to stop this cycling process, wake up the console by pressing the On/Off key and then press the STOP key.

INFORMATION DISPLAY

The steps described below are used to set:

- ▲ the date,
- ▲ time,
- ▲ job number,
- ▲ serial number,
- ▲ operator identification.

From the Main operating display proceed as follows:

1. **Press** the "INFO" key and the Information display appears:

```
   scintrex data acquisition system v1
TIME:  hh:mm:ss      SER.#: sssssssss
DATE:  yy:mm:dd      JOB #:   jjjjjjj
                     OPERATOR:ooooooo


                              MEMF:ppp%
Chg?:ENT.                     BATT:bbb
```

2. Move the cursor to `TIME:`

3. **Enter!** the current *hour.*

4. Move the cursor one step →

5. **Enter!** the current *minute.*

6. Move the cursor one step →

7. **Enter!** the current *seconds* or set to zero.

8. Move the cursor to `DATE:`

9. **Enter!** the current *year.*

10. Move the cursor one step →

11. **Enter!** the current *month* (numeric entry **1** to **12**).

12. Move the cursor one step →

13. **Enter!** current *day* (numeric entry **1** to **31**).

14. Move the cursor to `SER#:`

15. **Enter!** the instrument serial number or other permanent identification.

16. Move the cursor to `JOB #:`

17. **Enter!** a *job number* or other unique identifier for the survey.

18. Move the cursor to `OPERATOR:`

19. See "Note entry" on page 7–23. for detailed instructions on how to enter alphanumerics.

Note: In order to set time automatically from your GPS receiver, connect the SMARTMAG console serial port (data output) to the serial port of our GPS receiver. Set the SMARTMAG current hour to '`99`'. The SMARTMAG console will then wait for the ASCII time tag with format:

```
UTC yy.mm.dd hh:mm:ss ab
```

This format is supported by Trimble 4000 series GPS receivers.

NOTE ENTRY

This section describes the steps needed to:

- ▲ enter unique text to be recorded with the present measurement,
- ▲ or how to enter text to be used as macros for use as quick-entry notes.

Identical keystrokes are also used to enter the operator's name in the previous paragraph.

Notes or macros may contain all letters and numbers as well as +, *, -. Entry procedures are similar to the **Enter!** procedure for entering numbers only, as discussed in previous sections. The Number keys now offer also three letters, which can be accessed by subsequent keystrokes such as: 1 A B C 1...

The "CLEAR" key allows deletion of erroneous entries, whereas the "NEXT" key allows spaces between words. New macros can be entered by simply over-writing the previous ones.

The following steps enter the macro "fence 1" as Note 1. Other macros would be entered similarly, except that they would be saved with Note 2, Note 3 etc.

From the Main operating display proceed as follows:

1. **Press** "NOTE" and the Note display appears.

```
NOTES: *nnnnnnnnnnnnnnnnnnnnnnnnnnnnnnn

MACROS:
1:ccccccccccccccc      2:ccccccccccccccc
3:ccccccccccccccc      4:ccccccccccccccc
5:ccccccccccccccc

Chg?:ENT.              BATT:bbb
```

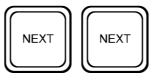
2. **Press** the "ENTER" key.

3. **Press** the "2" key repeatedly until f appears.

4. **Press** the “NEXT” key. If the following character is on a different key, there is no need to press the “NEXT” key.

5. **Press** the “2” key again until `e` appears.

6. Continue entering in the same way until ‘`fence`’ is completed.



7. **Press** the “NEXT” key twice.

8. **Press** the “1” key.

9. **Press** “ENTER”.

10. **Press** the “NOTE” key, followed by the “1” key. You should now see `fence 1` appear further down, under `MACRO: 1`

Unique notes, belonging to one reading only, are entered in the same way, with the exception that step 10 is omitted. The note will then be recorded along with the data. The note entry field is then cleared.

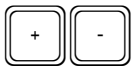
DISPLAY INTENSITY CONTROL

The display intensity gets pre-set at each cold boot and seldom needs to be adjusted. If it does, proceed as follows.

From the Main operating display:

1. **Press** the "AUX/LCD" key, and the Auxiliary Function display appears.

```
          auxiliary functions

        (+- ESC)      LCD Intensity
         (1)Data Output
         (2)Factory Test *
         (3)Lock       OFF
         (4)Reprogram System
Select function
```

2. **Press** the "+" or "–" key to adjust the intensity of the display to your satisfaction.

3. **Press** "ESCAPE" twice to return to the Main operating display.

PARAMETER LOCK

The SMARTMAG instrument setup and mag setup parameters can be locked to prevent accidental change. To do so, proceed as follows.

From the Main operating display:

1. **Press** the "AUX/LCD" key to bring up the Auxiliary display.

```
          auxiliary functions

        (+- ESC)      LCD Intensity
         (1)Data Output
         (2)Factory Test *
         (3) Lock       OFF
         (4)Reprogram System
Select functio
```

2. **Press** the "3" key to toggle the locking feature ON.

3. Do your work...

4. To unlock the instrument repeat steps **1** and **2**, except that now the locking is toggled to OFF.

5. **Press** "ESCAPE" to return to the Main operating display.

REPROGRAMMING THE OPERATING SYSTEM

The flash EPROM's (erasable, programmable read only memory) of the SMARTMAG can be updated from your computer using the software supplied by SCINTREX.

At the computer

1. Note the name of the upgrade program (usually SMFLASH.SYS, written on the label of the supplied disk).
2. Insert the supplied disk into your floppy drive (A: or B:).
3. Start the program FASTCOM, i.e. enter F A S T C O M.
4. You will then be asked to enter the name of the download program from step 1, i.e. SMFLASH.SYS or what ever was on the disk.
5. The PC will display: "WAITING...". At this point it is waiting for the SMARTMAG console to come on line.

At the SMARTMAG Console

Warning: Make sure you have dumped all of your data, otherwise it will be erased.

From the Main operating display in the advanced mode:

1. **Press** the "AUX/LCD" key to bring up the Auxiliary display.

```
          auxiliary functions

        (+- ESC)      LCD Intensity
         (1)Data Output
         (2)Factory Test *
         (3) Lock      OFF
         (4)Reprogram System
Select function
```

2. Make sure the *baud rate* under `Data Output` is set at `19200`.

3. **Press** the "4" key to start the procedure.

4. You will now see a warning and confirmation screen as follows:

```
          !  !  !  WARNING  !  !  !

You are about to REPROGRAM your current
version of the operating system. This
process will also destroy all of your
stored data if any.

       Do you want to proceed ? (Y/N)
```

5. **Press** the "Y" key to continue.

6. At this point the PC will start to display the activity of the download procedure showing the percentage that is complete.

7. When the download is finished, i.e. 100% complete on the PC, *wait* for about 10 to 15 seconds for the SMARTMAG to reprogram. The SMARTMAG will then automatically perform a cold boot and you are ready to survey.

Note: If the download is interrupted (power shut-down at either the PC or SMARTMAG end), you will have to repeat the above steps. If the SMARTMAG does not reboot for some reason, you must power the unit off and then on. The screen may not be functional, but the bootstrap program is running. Start the download from the PC again.

Chapter 8

OPERATING THE SMARTMAG WITH THE CONSOLE

The information in this chapter is not intended to be a complete tutorial on magnetic surveying, rather it highlights the unique features of the SMARTMAG. The *Applications* booklet covers this subject in more detail. This chapter will cover the following:

- guidelines for obtaining accurate, meaningful measurements,
- tips on field procedures with the SMARTMAG,
- a sample WALKMAG (automatic) mode of survey (basic mode),
- a sample Stop-and-Go (semi-automatic) mode of survey (advanced),
- base-station operation (advanced),
- search-mode surveys,
- data correction procedures using the base-station, tie-line or loop survey modes.

ACCURATE AND MEANINGFUL MEASUREMENTS

The quality of your measurements are greatly affected by the sensor orientation, magnetic gradients and any other source of noise near the sensor. Accurate, meaningful measurements can only be made by observing some simple guidelines as discussed in the following sections.

DETERMINING OPERATING ZONES

In order to determine the operating zones of the SMARTMAG, you must face magnetic north. By swinging the sensor head to the ground and then upwards, you will be able to determine the angular range of operation by either the audio or display reading. When the sensor head is out of the operating range, the audio will vary wildly, and the display reading will go out of range (range 20,000 to 99,999 gammas). *Preferably, the staff should be oriented so that it lies in the center of the angular range as just described.*

While still facing magnetic north, the range of the sweep operation may be determined by swinging the SMARTMAG staff to the left and then to the right. The usable sweep angle will depend upon your geographical position.

If sweep operations are then conducted while walking in a northerly direction, the allowable sweep motion will be known by the previous test.

To determine the proper staff position and sweep angle for walking south, perform the previous tests while facing south.

EFFECTS OF GRADIENT

Many small items carried by the operator in addition to the magnetometer may be magnetic and therefore upset, locally, the magnetic field to be measured. Such items are notebooks, pencils, cigarette lighters, eyeglasses, dentures etc., just to mention a few.

OTHER SOURCES OF NOISE

Other sources of noise can be objects such as belt-buckles, GPS antennas, etc. that move relative to the sensor head while surveying. When it is not possible to remove the noise source, the noise can be minimized by preventing any relative motion with respect to the sensor. This can be accomplished by keeping the sensor staff as stable as possible (i.e. keep the sensor head from bobbing up and down) while walking. Orientation errors will also be minimized in this way.

BASE-STATION

The Base-station is normally installed as close to the actual survey area as practical to minimize spatial differences in the magnetic field.

REPEATED SURVEYS LINES

If it is necessary to repeat a set of measurements on a survey line, you should take certain precautions to ensure data handling is done in the most effective manner. The SMARTMAG recalls or outputs repeated data sequentially by time at the same locations, resulting in unsightly (or unintelligible) recall displays. You will also have to substantially edit your data files to properly use them with the ENVIMAP software.

Hint: It is recommended that you assign a minor increment to the survey line number prior to re-surveying to avoid problems. For example, if you are about to re-survey line 40N, enter the line number as 40.1N instead.

WALKMAG– TOTAL-FIELD/GRADIOMETER (AUTOMATIC MODE)

The following sets of instructions will lead you step by step through the first three survey lines of an imaginary total-field survey looking for buried drums. This should give you a better understanding of what you will be required to do when doing your SMARTMAG survey.

- It is assumed that the lines are marked and pegged intervals of 10 units.

Figure 38 Typical WALKMAG configuration.

Press the "SETUP" and "ON" keys simultaneously and select configuration `2-Drum Locations`. This is described fully in "Basic mode configuration displays" on page 6–12.

CHECK YOUR SETUP

1. Set up Line and Station Number and Separations as shown in the example under "Line and Station setup" on page 7–7.

2. Do the setup shown under "Sample total-field setup" on page 7–9.

START SURVEY

3. Proceed to your first location.

4. **Press** the "START" key.

5. If you wish to enter the graphics display mode, then press the "NUM/GRAPH" key.

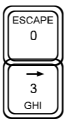
6. Proceed immediately with your desired pace toward the West.

7. **Press** the "NEXT" key when the *sensor* passes the first station peg. If you trigger the station marker at the time that you yourself pass the station, rather than the sensor, you will likely introduce a herring-bone pattern into the survey data. Observe how the Station Number decrements.

8. Repeat the previous step at each peg.

9. At Station 50 W, **Press** "STOP" right after you have pressed "NEXT".

10. If you are not already in the graphics mode, then you can now inspect your data graphically (before you press "ESCAPE") by pressing the "NUM/GRAPH" key. This will show you up to the last 178 readings on the line.



11. **Press** the "ESCAPE" key.

12. Move the cursor to `ST: SEP:`

13. **Enter!** 10.

14. Move the cursor to `LN:`

15. **Press** the + key. The Line number increments to 18.

16. Proceed to Line 18 N, Station 50 W.

17. **Press** the "START" key.

18. Press the "NUM/GRAPH" key to enter the graphics display mode.

19. Proceed *immediately* walking to the East.

20. At each peg, **Press** the "NEXT" key.

21. At Station 50 E, **Press** "STOP" right after you have pressed "NEXT."

22. **Press** the "ESCAPE" key.

23. Change the `ST: SEP:` to -10.

24. Move the cursor to `LN:`

25. **Press** the "+" (plus) key. The Line number increments to 20.

26. Proceed to Line 20 N, Station 50 E.

27. **Press** "START", and proceed walking to the West again etc. The beep indicates the start of the first reading which belongs to Station 50 E.

WALKGRAD GRADIOMETER SURVEY

A walking type of gradiometer survey is done in the same manner, with the following exceptions:

▲ At the `MODE:` select `GRAD`.

MANUAL MODE– TOTAL-FIELD/GRADIOMETER (SEMI-AUTOMATIC)

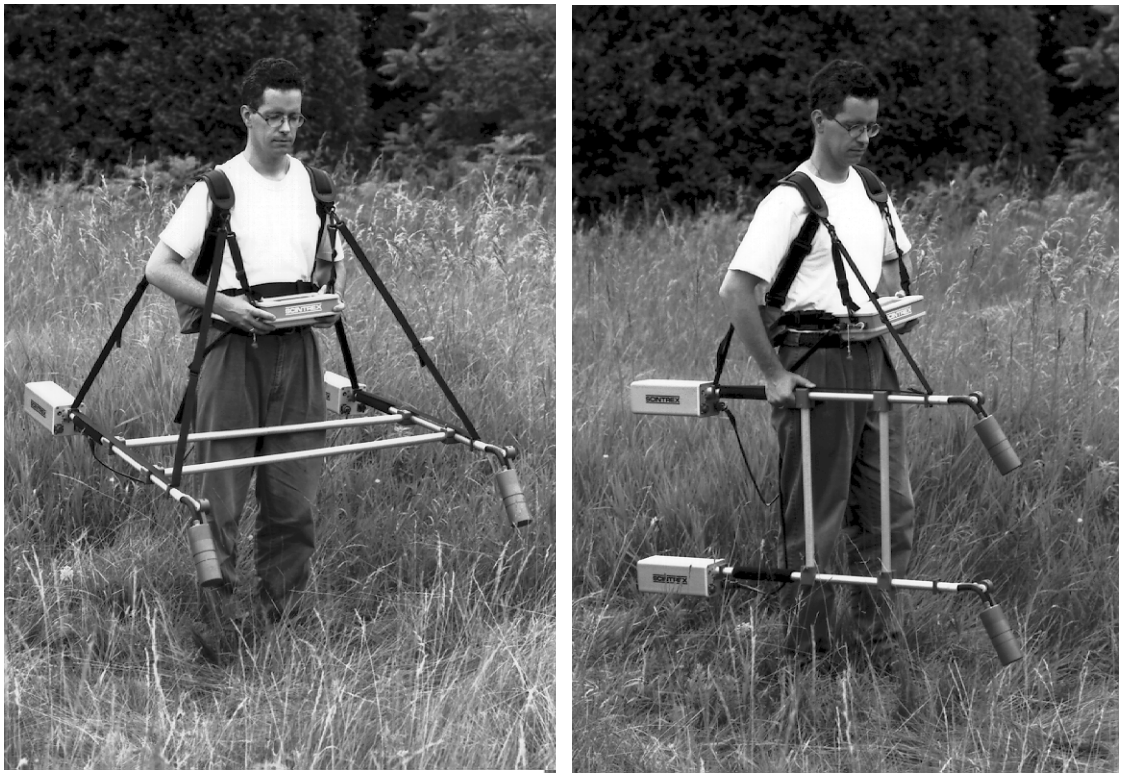


Figure 39 Typical gradiometer configurations.

Press the “ON” and “SETUP” keys simultaneously to get the configuration menu. Select configuration `6-Mineral Exploration`. This is described fully in “Configuration menu” on page 7–3.

CHECK YOUR SETUP

1. Set up Line and Station Number and Separations as shown in the sample setup on page 7–7.

2. Do the setup as shown under “Instrument setup” on page 7–14, except set the:

   ▲ `CYCLE REPEAT:` as `no`

3. Do the setup as shown under “Sample total-field setup (WALKMAG or WALKGRAD)” on page 7–15.

4. Enter a Note as shown under “Note entry” on page 7–23.

START SURVEY

5. Proceed to your first location.

6. Hold the sensor steady and **Press** the “START” key to take a reading.

7. Inspect the data.

8. Re-adjust the `LOCAL FIELD` in the `mag setup` if necessary to the current total-field value.

9. **Press** the “RECORD” key to save the data.

10. **Press** “ESCAPE”, optionally followed by “OFF”.

11. Proceed to the next station to the West.

12. Move the cursor to `ST:`

13. **Press** the “+” key. Verify that the Station has decremented to 40 W.

14. Take a reading and record the data.

15. Continue along the line and take a reading at each station.

16. At 10 W, before you press the "START" key, **Press** the "NOTE" key and then the "1" key to enter the note "fence 1". You may also enter your Macro or any unique note after the measurement, but before you **Press** the "RECORD" key.

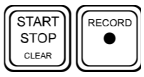
17. After completing 50 W, proceed to 50 W on Line 18 N.

18. At the Main operating display move to cursor to `ST: SEP:`

19. **Enter!** 10.

20. Move the cursor to `LN:`

21. **Press** the "+" key to increment the line number to 18 N.



22. Take a reading and proceed along line 18 N toward the East.

23. At 10 W again, before you press the "RECORD" key, **Press** the "NOTE" key, and then the "1" key.

24. After you have finished the line, move to Line 20 N and proceed to 50 E.

25. At the Main operating display move the cursor to `ST: SEP:`

26. **Enter!** -10.

27. Move the cursor to `LN:`

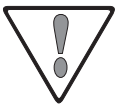
28. **Press** the "+" key to increment the line number to 20 N.

29. Proceed with Line 20 N.

AUTOMATING YOUR MEASUREMENTS

There are two items which can be automated after each measurement:

- ▲ data recording,
- ▲ altering of the Station Number can take place automatically.



Caution: Please note that *repeat measurements* will alter the Station Number and possibly disrupt the correlation between location and data.

To enable both features do the following:

1. In the Instrument setup, move the cursor to `AUTO ST.INC.:` **Select!** YES

2. In the `mag setup`, move the cursor to `AUTO RECORD:` **Select!** YES

To operate as a total-field magnetometer in the Stop-and-Go mode, make the following change in the `mag setup:` screen,

`MODE: T-FLD`

BASE-STATION OPERATION

Base-station operation is a simple matter of setting up the equipment and getting it operational. A single base-station can be used with a multiple of mobile (portable, airborne) instruments. The base-station sensor should have the same location for multi-day projects.

IMPORTANT:
It is of **UTMOST IMPORTANCE** that the **DATE** and **TIME** coincide on all instruments to successfully correct the mobile data.

Proper correction also requires a *base field* value, which has to be entered into **ALL** magnetometers before the base-station correction takes place. This usually is one of the first readings of the base-station taken on the first day of an extended survey. This value **MUST NOT** be changed while in the same area.

After all the equipment has been set up and connected, proceed as described in steps 1–3 to set up the instrument (or at least to verify proper settings as shown in the "Sample base-station setup" on page 7–18). You may have to cold boot your SMARTMAG and select one of the advanced configurations (5 to 7).

CHECK YOUR SETUP

1. Set up Line and Station Number to the actual location of the base-station. This is recommended to avoid later confusion.

2. Do the setup as shown under "Instrument setup" on page 7–14, except set:
   ▲ `CYCLE REPEAT:` as `no`

3. Do the setup as shown under "Sample base-station setup" on page 7–18.

START OPERATION

4. **Press** the "START" key, read the console message and act accordingly.

*5. After two or three readings, **Press** the "STOP" key. (See A4-23 note on Stopping base station cycling).

*6. **Press** the "ESCAPE" key.

*7. Bring up the MAG SETUP display by moving the cursor to `mag setup` and pressing the "ENTER" key.

*8. **Enter!** the measured total-field value as `LOCAL FIELD:` and also as the `BASE FIELD:`

*9. **Enter!** the Base Field into all mobile units.

*10. **Press** the "ESCAPE" key and resume the measurement.

11. **Press** the "NUM/GRAPH" key to show the graph.

12. **Press** the "+" or "–" key to change the sensitivity of the graph. The new full-scale value is shown briefly on the message line at the bottom of the display. You can also press the "0" (zero) key to center the graph vertically.

***Optional steps**

Note: Data scrolled off the screen may be inspected with the RECALL feature. This, however, requires interruption of data acquisition. A change in the graph sensitivity does not affect the recorder sensitivity.

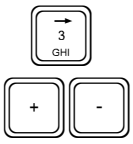
SEARCH MODE

The *search* mode is useful for small areas where simple targets can be located immediately, without data plotting and interpretation. Examples are paved-over utility covers or valves etc. Due to the possibly small physical size of the target it is necessary to use the highest sampling rate and slow sweep rate. The total-field sensor or the base-station sensor can be used. You will need to specify which one you are using.

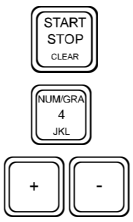
BASIC

Press the "ON" and "SETUP" keys simultaneously to get the configuration menu. Select configuration `4-Search Magnetometer`: This is described under "Configuration menu" on page 7–3. You then can follow the setup as described under "Search Mode" on page 7–12. You only need to enter *one* value before you start:

- ▲ the correct hemisphere setting (`HEM`)



1. Move the cursor to `HEM:`
2. Press the "+" or "–" key to select `N` (if you are operating the SMARTMAG in the northern hemisphere) or `S` (if you are operating the in the southern hemisphere).



3. Press the "START" key.
4. Press the "NUM/GRAPH" key for graphical display of the data.
5. Press the "+" or "–" key to change the sensitivity of the graph. You can also press the "0" key to center the graph vertically.

6. To change the sample rate:

a. Press the "NUM/GRAPH" key to display the data numerically.

b. Press the "ENTER" key. A ">" will appear following the "RATE", e.g. RATE:>5.

c. Press "0", "1", "2", or "5" for 10, 1, 2 or 5 readings/sec respectively.

7. Press "NUM/GRAPH" to get the graphical display of the data.

ADVANCED

In the advanced mode you may want to alter other settings in the main Search page. In addition to the hemisphere setting as described in steps **1** and **2**, on the previous page, the following may also be controlled:

- ▲ low pass filter bandwidth (BW),
- ▲ the audio sensitivity (PITCH),
- ▲ the local field values in nanoTeslas (LOCAL FLD).

SURVEY DATA CORRECTION PROCEDURES

The purpose of data corrections is to remove diurnal and micro-pulsation effects of the Earth's magnetic field. This gives you the cleanest data possible for interpretation. However, these procedures may not be necessary, if your goal is only target identification (anomaly hunting). Please refer to the *Applications* booklet, for a more thorough discussion on this topic.

USING BASE-STATION DATA

You can only use base-station data when you have selected one of the advanced (5–7) survey configurations. This procedure describes the correction when using SMARTMAG only. The correction with different instruments must be done independently on a computer.

Caution: The base-station correction physically modifies the data of the mobile units, but does not alter the base-station's data. Please make certain that the Base Field value in the field unit is correct before proceeding.

To correct your data, proceed as follows:

1. Connect the units as shown.

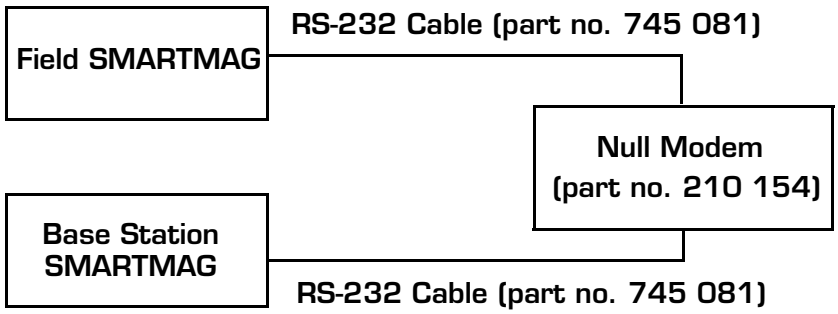
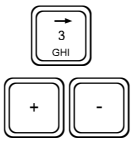


Figure 40 Connections for the Base-station correction.

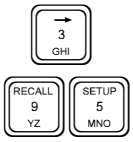
2. Proceed, on both units, to the `mag setup:` display.



3. Scroll, on both, to `BASE CORRECT.:`

4. **Select!** `YES`.

5. You will now see a warning message on the right side of the display of the field unit indicating that the raw data in the field SMARTMAG will not be preserved.



6. **Press** the "START" key on both. Either one can be started first.

7. You will be asked to confirm the start of the data correction by pressing either the "Y" or "N" key.

8. When finished, **Press** the "ESCAPE" key.

TIE-POINT (TIE-PT) MODE

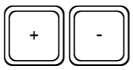
This type of correction procedure uses data from repeated stations during the course of the survey to correct for the variations in the earth's magnetic field. It should be noted however that this correction method is not as accurate or precise as the Base-station Correction method. A technical paper on this subject "*Magnetic Correction Techniques*", is available from SCINTREX. For more details, please also refer to the *Applications* booklet.

Note: Both Looping and Line-type methods can be applied to either a WALKMAG or a Stop-and-Go type of survey. However, for the Line type, the tie-line itself must be done in the Stop-and-Go mode.

Loop type–collecting data

This is the default mode available when you select any of the basic configurations (1–3) from the configuration menu. To select the `LOOP` mode, call up the `mag setup:` display and:

9. Move the cursor to `TIE-MODE:`



10. Select! `LOOP`

11. Pick a location in your survey area that you can conveniently come back to during the course of your survey.

12. At your designated tie-point location, press the “TIE-PT” key instead of the “START” key.

13. Proceed with your normal survey, but return to your designated tie-point on a regular basis. Always take readings using the ”TIE-PT” key instead of the start key at this location. This is illustrated in the following diagram.

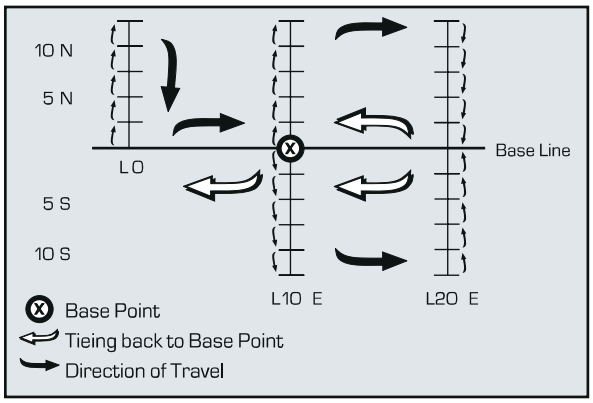


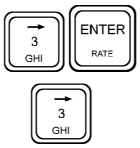
Figure 41 Looping method for collecting correction data

Line type–collecting data

This mode is only available when using the advanced configurations (5–7). See “Configuration menu” on page 7–3.

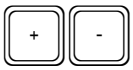
During a traversal along the tie-line you have chosen, the Station numbers are kept constant, but the Line numbers are changed.

It is assumed that the instrument has been fully set-up in advance for other functions. A few setup items have to be changed:



1. Call up the `instrument setup` display.

2. Move the cursor to `AUTO STN.INC.:`



3. **Select!** `NO`.

4. Call up the `mag setup:` display.

5. Move the cursor to `TIE-MODE:`

6. **Select!** `LINE`.

7. Return to the Main operating display.

8. Move the cursor to `STN:` in the Locations block on the right side.

9. **Enter!** the Station number at the Tie-Line.

10. Move the cursor to `LN:`

11. **Enter!** the Line number at the start of the Tie-Line.

12. **Press** the "TIE-PT" key to take a measurement and record it.

13. Proceed to the next line.

14. Move the cursor to `LN:`

15. **Press** the "+" or "–" key, as needed, to change the Line number.

16. Repeat steps 12–15 to complete collecting the tie-line data.

17. Proceed with your normal survey as shown.

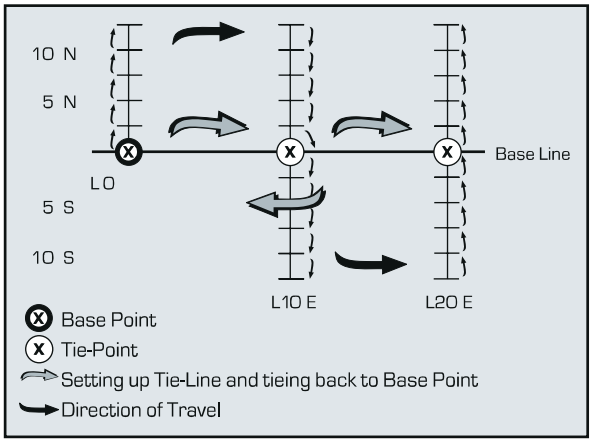


Figure 42 Tie-line method for collecting correction data

Note: If you need more than one day to complete your survey in the Line-type mode, please make sure that you collect *all* your Tie-points as the first data that you store in memory, i.e. before you survey any lines. This ensures that they will not be erased when clearing memory to make room for the next day's data.

TIE-POINT CORRECTION PROCEDURE

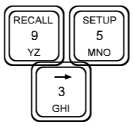
The Tie-point correction is performed as follows:

Basic modes (Loop only)

1. Move the cursor to `TIE:`.

2. **Press** the "ENTER" key.

3. You will now see a warning message on the right side of the display indicating that the data will be altered.



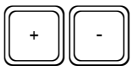
4. **Press** the key containing "Y" for yes or "N" to abort.

5. When finished, **Press** the "ESCAPE" key.

Advanced modes

1. Call up the `mag setup` display.

2. Move the cursor to `TIE CORRECT:`



3. **Select!** `YES`.

4. You will now see a warning message on the right side of the display indicating that the data will be altered.

5. **Press** the "START" key.

6. You will now be asked to confirm the correction operation by pressing either the "Y" or" "N" keys.

7. When finished, **Press** the "ESCAPE" key.

DATA OUTPUT

There are many different types of computers and printers on the market. Consequently, only general instructions on how to dump the data will be given. The ENVIMAP software supplied with this instrument has a communications feature, and its operation is discussed in Section B of this manual. Other communications programs are also suitable to retrieve the data from the SMARTMAG. Please contact SCINTREX if you are interested in a specialized high-speed downloading program.

The RS-232 cable, SCINTREX P/N 745 081, links the SMARTMAG data output connector and the serial port of the computer or printer.

Note: The null modem (SCINTREX P/N 210 154), as used for the base-station correction, *must not* be used here.

OUTPUT FORMATS

In the advanced mode (configurations 5 to 7), the data can be dumped in several different formats. These formats are discussed here with sample data shown for each. The data output is fully left-justified with a maximum line length of 80 characters. A description of the data fields is given by the `Mag data` line of the header for each format.

XYZ

The XYZ format is the *recommended format* to be used in conjunction with the ENVIMAP processing program.

The XYZ format does *not* have a header section *nor* does it contain NOTES.

A short sample of the format follows:

Total Field

```
10 690 77171.60 22.158389 0
10 692.5 77171.57 22.158444 0
10 695 77171.58 22.158500 0
10 697.5 77171.59 22.158556 0
10 700 77171.60 22.158611 0
10 700.556 77171.56 22.158667 0
10 701.111 77171.57 22.158722 0
10 701.667 77171.57 22.158778 0
10 702.222 77171.59 22.158833 0
```

Gradiometer

```
10 620 77171.58  77171.60  22.073389 0 -0.05
10 622.5 77171.59  77171.59  22.073444 0 0.00
10 625 77171.61  77171.56  22.073500 0 0.09
10 627.5 77171.59  77171.60  22.073556 0 -0.02
10 630 77171.57  77171.63  22.073611 0 -0.12
10 632 77171.59  77171.63  22.073667 0 -0.08
10 634 77171.60  77171.60  22.073722 0 0.00
10 636 77171.59  77171.63  22.073778 0 -0.08
```

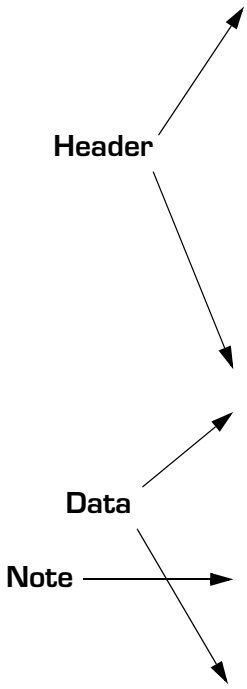
The data fields from left to right are:

- X
- Y
- Total Field 1 (& Total Field 2 for the SM–4G)
- Hours
- Correction flag: 0=uncorrected
- (Gradient for the SM–4G)

XYZ+

The XYZ+ format has a header section and contains user entered NOTES, but it is otherwise identical to XYZ.

Total Field




```
//-------------------------    S C I N T R E X    --------
/!Revision:2.0
/!Line____:10.0000 +
/!Date____:96/04/10
/!Job_____:0
/!Operator:
/!Serial__:0
/!Basefld_:0
/!Rate____:5.0
/!Bandw___:8.0
/!Mag_Data:X/Y/TotFld/Hours/0=Uncor
/-----------------------------------------------------------
10 690 77171.60 22.158389 0
10 692.5 77171.57 22.158444 0
10 695 77171.58 22.158500 0
10 697.5 77171.59 22.158556 0
10 700 77171.60 22.158611 0
/Npipe:
10 700.556 77171.56 22.158667 0
10 701.111 77171.57 22.158722 0
10 701.667 77171.57 22.158778 0
```

Gradiometer

Repeat of header data up to and including `Bandw:`

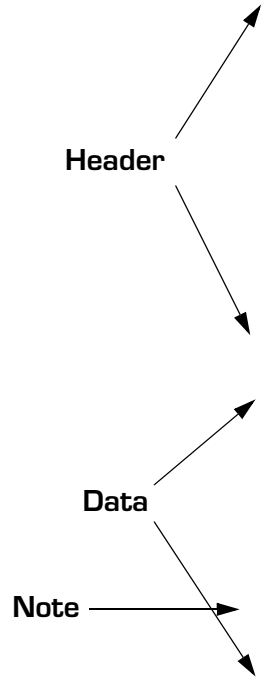
```
/!Sens.sep:0.5m
/!Mag_Data:X/Y/TotFld1/TotFld2/Hours/0=Uncor/Grad
/-----------------------------------------------------------
10 620 77171.58  77171.60  22.073389 0 -0.05
10 622.5 77171.59  77171.59  22.073444 0 0.00
10 625 77171.61  77171.56  22.073500 0 0.09
/Npipe:
10 627.5 77171.59  77171.60  22.073556 0 -0.02
10 630 77171.57  77171.63  22.073611 0 -0.12
```

XYZ++

Note: This is the default format for the Basic mode (configurations 1–3).

The XYZ++ format also has a header section and user entered NOTES. The distinguishing feature is that the data is placed into columns. The ENVIMAP software is specially configured to read this format.

Total Field




```
/-------------------------- S C I N T R E X --------
/!Revision:2.0
/!Line____:10.0000 +
/!Date____:96/04/10
/!Job_____:0
/!Operator:
/!Serial__:0
/!Basefld_:0
/!Rate____:5.0
/!Bandw___:8.0
/!Mag_Data:X/Y/TotFld/Hours/0=Uncor
/-----------------------------------------------------
          10           690  77171.60  22.158389  0
          10         692.5  77171.57  22.158444  0
          10           695  77171.58  22.158500  0
          10         697.5  77171.59  22.158556  0
          10           700  77171.60  22.158611  0
          10       700.556  77171.56  22.158667  0
/Npipe:
          10       701.111  77171.57  22.158722  0
          10       701.667  77171.57  22.158778  0
```

Gradiometer

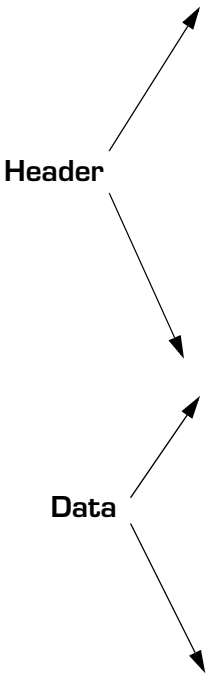
Repeat of header data up to and including `Bandw:`

```
/!Sens.sep:0.5m
/!Mag_Data:X/Y/TotFld1/TotFld2/Hours/0=Uncor/Grad
/-------------------------------------------------------------
         10           620  77171.58  77171.60  22.073389  0    -0.05
         10         622.5  77171.59  77171.59  22.073444  0     0.00
         10           625  77171.61  77171.56  22.073500  0     0.09
/Npipe:
         10         627.5  77171.59  77171.60  22.073556  0    -0.02
```

PRN

The PRN format is compatible with software written for the SCINTREX MP–3/4 magnetometer.

Total Field




```
/-------------------------- S C I N T R E X ---------------
/!Revision:2.0
/!Line____:10.0000 +
/!Date____:96/04/10
/!Job_____:0
/!Operator:
/!Serial__:0
/!Basefld_:0
/!Rate____:5.0
/!Bandw___:8.0
/!Mag_Data:Station/Dir/TotFld/Time/*=Uncor/Notes
/-----------------------------------------------------
         690 +  77171.60  22:09:30.2  *
       692.5 +  77171.57  22:09:30.4  *
         695 +  77171.58  22:09:30.6  *
       697.5 +  77171.59  22:09:30.8  *
         700 +  77171.60  22:09:31.0  *  pipe
     700.556 +  77171.56  22:09:31.2  *
     701.111 +  77171.57  22:09:31.4  *
     701.667 +  77171.57  22:09:31.6  *
     702.222 +  77171.59  22:09:31.8  *
```

Gradiometer

Repeat of header data up to and including `Bandw:`

```
/!Sens.sep:0.5m
/!Mag_Data:Station/Dir/TotFld1/TotFld2/Grad/Time/*=Uncor/Notes
/-----------------------------------------------------------------
         646 +  77171.58  77171.59    -0.03  22:04:27.8  *
     646.667 +  77171.56  77171.61    -0.09  22:04:28.0  * pipe
     647.334 +  77171.63  77171.60     0.06  22:04:28.2  *
         648 +  77171.60  77171.56     0.08  22:04:28.4  *
     648.667 +  77171.59  77171.59     0.00  22:04:28.6  *
```

NOTES

The NOTES output format just retrieves your manually entered NOTES and macros. In the output, it shows them with their respective line and station values.

For example, from the data in the Total Field PRN file on the previous page, you would see the following:

```
/ X: Line 10.0000 + / Y: Stn 700 + / pipe
```

BINARY

A binary dump transfers your SM–3 data to a PC in a compact and efficient binary format. This binary data file may then be converted to any of the previous formats by means of the XFSMART.EXE program.

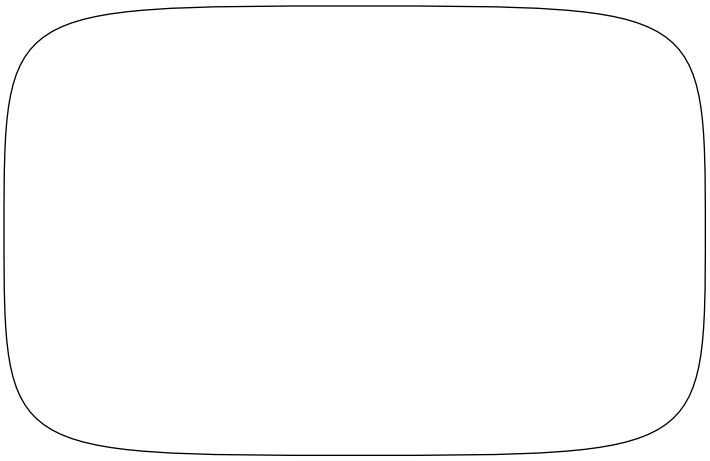
You must use the BINDUMP program on the PC and connect with a baud rate of 19200.

Converting binary data with XFSMART

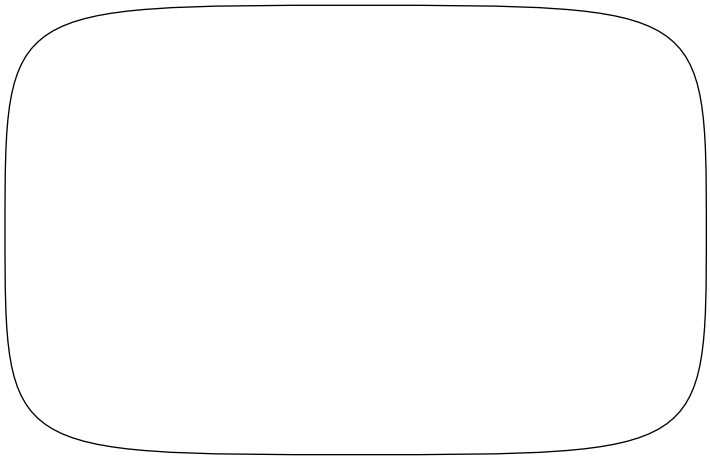
The XFSMART program is a DOS-based PC program that converts the binary output file to any of the XYZ, XYZ+, XYZ++ or PRN formats.

1. Start the program on your PC by entering:
   X F S M A R T and ↵.

   You will then see the following screen

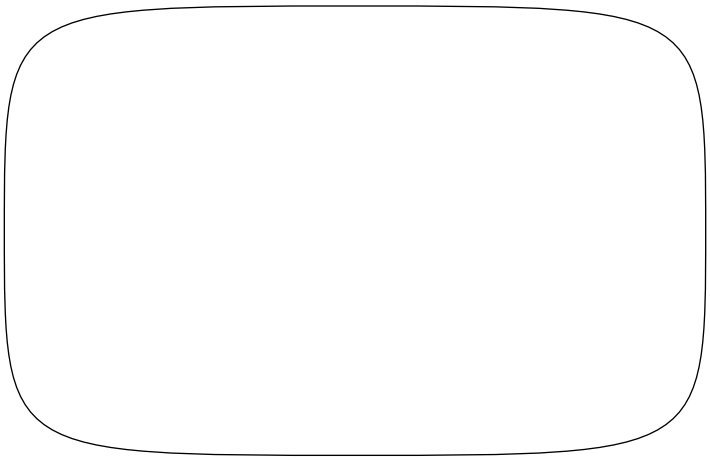


2. Select either option 0=BY_LINE or 1=ALL_OF_FILE for the SM–3 by pressing either the [0] or [1] keys. You will then see:



3. Select either option 0=XYZ, 1=XYZ+, 2=XYZ++ or 3=PRN for the SM–3 by pressing either the [0], [1], [2] or [3] keys.

4. You will then need to enter the name of your binary input file and the name of your output file. The prgram will automatically perform the conversion after you have supplied both file names. The bottom line displays the status of a succesful conversion.



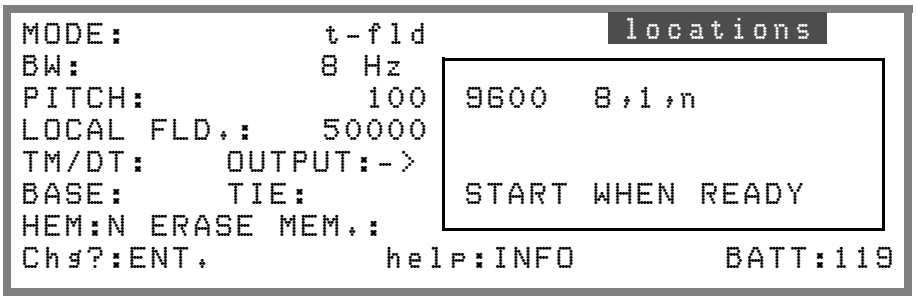
BASIC MODE

When using configurations 1–3, the output procedure is quite simple, as the serial communications parameters are fixed at 9600 baud, 8 bits, 1 stop bit and no parity, while the data format is set as XYZ++ (see page 9–4 for details).

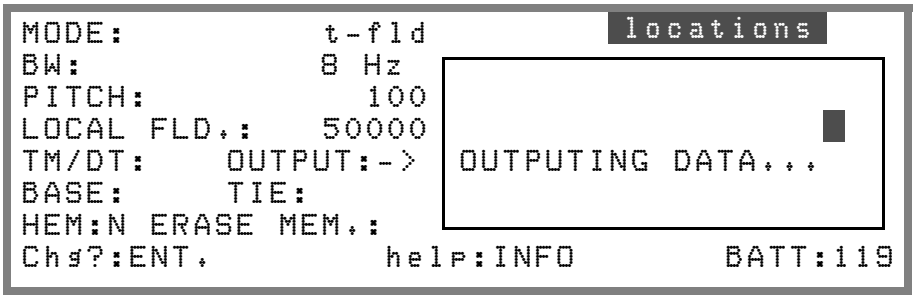
1. Connect the SMARTMAG to the serial port of your computer, using the RS-232 cable (SCINTREX P/N 745 081).
2. Start your ENVIMAP or other communications program, in order to receive data.

From the Main operating display of the SMARTMAG:

3. **Move** the cursor to the OUTPUT: field.
4. **Press** the "ENTER" key and you will see the following status window:.



5. **Press** the "START" key to upload your data to the computer. You will see a confirmation message that the operation is taking place.



ADVANCED MODE

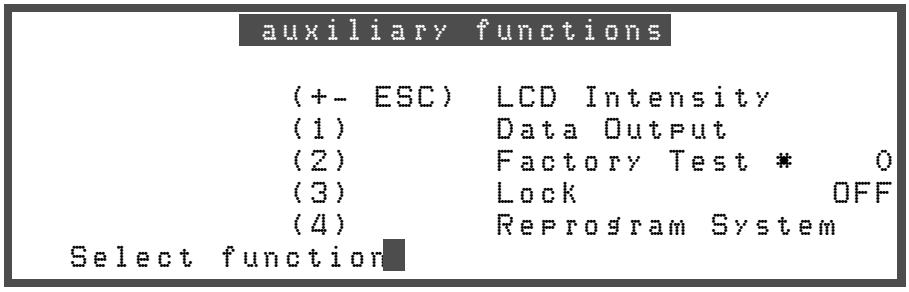
The data output and its setup functions are all accessible from the START output of: display. Please refer to "Data output display" on page 6–35 for detailed explanations of all the parameters.

1. Connect the SMARTMAG to the serial port of your computer, using the RS-232 cable (SCINTREX P/N 745 081).
2. To receive data, start your ENVIMAP or other communications program.

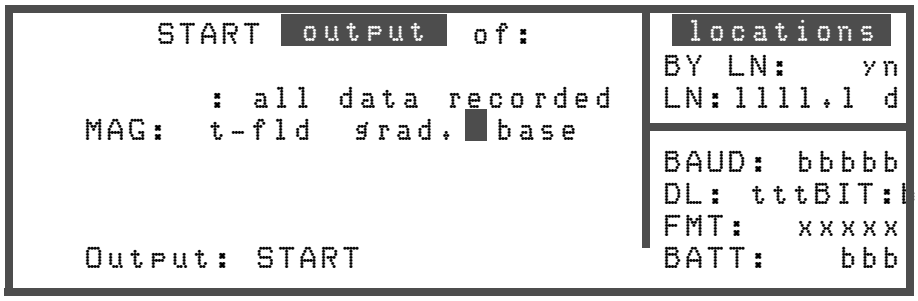
OUTPUT SETUP

From the Main operating display of the SMARTMAG:

3. **Press** the "AUX/LCD" key,



4. **Press** the "1" key to get the START output of: display.



At the START output of: display proceed as shown:

5. **Press** the "NEXT" key until the cursor rests within the lower *right* sub-page, i.e. the communications block.
6. Move the cursor to `BAUD:`
7. **Select!** your desired baud rate.

Note: The baud rate on the SMARTMAG *must match* the baud rate on the output device for successful communication.

8. Leave `DL:` at 0 and `BIT:` 8
9. Move the cursor to `FMT:`
10. **Select!** the desired output data format (see "Output formats" on page 9–1).

Caution: If some characters are lost during the dump, (an occurrence in particular to some printers), it may be necessary to set the delay `DL:` to a value between 0 and 999. The actual value has to be established experimentally. `BIT:` may need to be changed to 7 to get the proper character font.

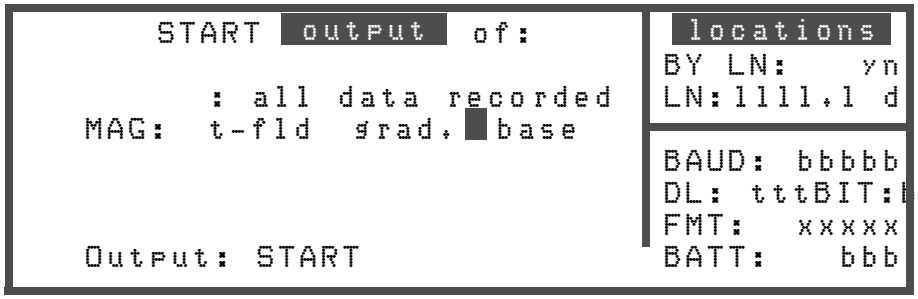
DUMPING DATA

Data can be dumped in four different ways:

- ▲ all data—regardless of method; one *big* sequential dump,
- ▲ by method or sub-method, i.e. total-field, gradient or base,
- ▲ on a line by line basis,
- ▲ binary memory dump when data loss has occurred (this file must be sent to SCINTREX for evaluation and data recovery).

All data

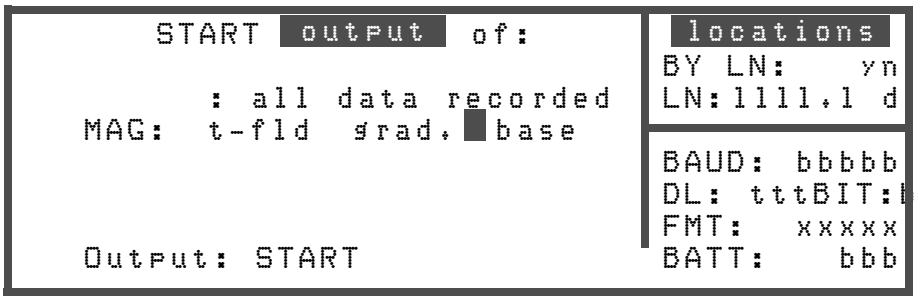
At the `START output of:` display proceed as shown:



1. **Press** the "NEXT" key until the cursor rests within the *left* sub-page.
2. Move the cursor to: `all data recorded`.
3. **Press** the "START" key.
4. Options:**Press** the "STOP" key to temporarily suspend dumping. **Press** the "ESCAPE" key to *abort* the dump.

Specific data

At the START output of: display proceed as shown:



1. **Press** the "NEXT" key until the cursor rests within the *left* subpage.
2. Move the cursor to one of the three data types at the MAG: field: t-fld grad, base.
3. **Press** the "START" key.
4. Options:
   Press the "STOP" key to temporarily suspend dumping.
   Press the "ESCAPE" key to *abort* the dump.

Binary Dump

To dump binary data:

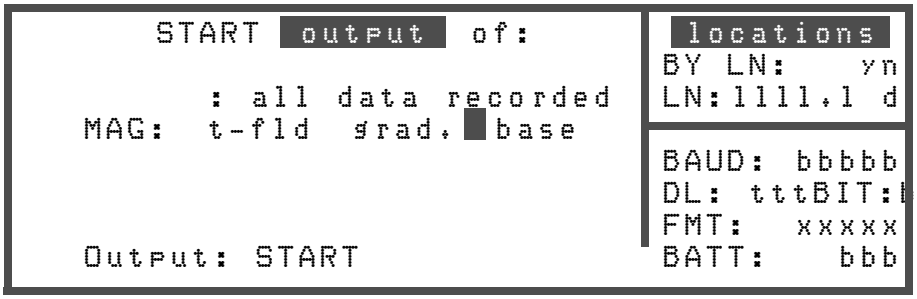
1. **Select!** 19200 or 57600 baud.
2. **Select!** binary format.
3. **Select!** all data recorded.
4. On the PC run the BINDUMP program that is provided with your SMARTMAG.

Note: The binary output format may be used to dump all of the memory for emergency use only. Set the factory test to 777, prior to a binary dump, to dump all of the memory. This pro-

cedure is to be used only if your data has been lost. Your binary file may be sent to SCINTREX for evaluation and if possible, data recovery.

Line by line

At the START output of: display proceed as shown:



1. **Press** the "NEXT" key until the cursor rests within the top *right* sub-page, i.e. the locations block.
2. Move the cursor to BY LN:
3. **Select!** YES to activate this function.
4. Move the cursor to LN:
5. **Enter!** the desired Line number and direction.
6. **Press** the "NEXT" key until the cursor rests within the *left* sub-page.
7. Move the cursor to one of: MAG: t-fld grad. base.
8. **Press** the "START" key.
9. Options:
   Press the "STOP" key to temporarily suspend dumping.
   Press the "ESCAPE" key to *abort* the dump.
10. Repeat steps **4** to **8** as required.
11. **Press** the "ESCAPE" key to return to the Main operating display.

ERASING DATA FROM MEMORY

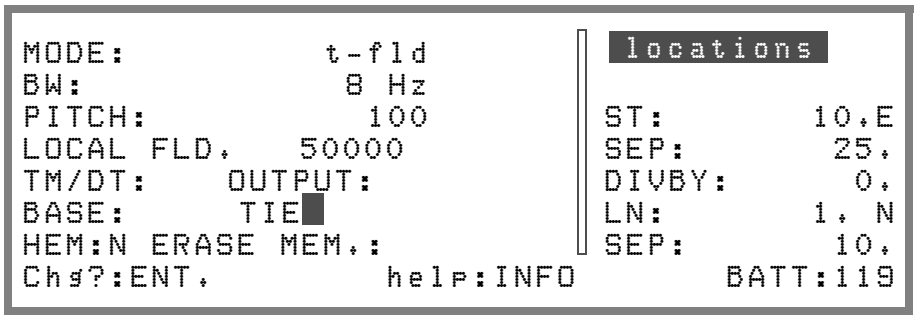
After you have successfully dumped your data to a computer and have verified that it is all there, you should free up the SMARTMAG's memory to prepare for your next survey. This is accomplished by activating the ERASE MEMORY option. This removes only the data from memory, but preserves the rest of your configuration parameters. To clear everything, you would have to do a *cold boot*.

If you are using the TIE-PT mode of diurnal correction with the Line option, there is a special provision for not clearing the TIE-PT data. This allows multi-day surveys to be corrected to the same set of control values. However, this also requires you to collect *all* of the TIE-PT data before you start surveying the rest of the grid.

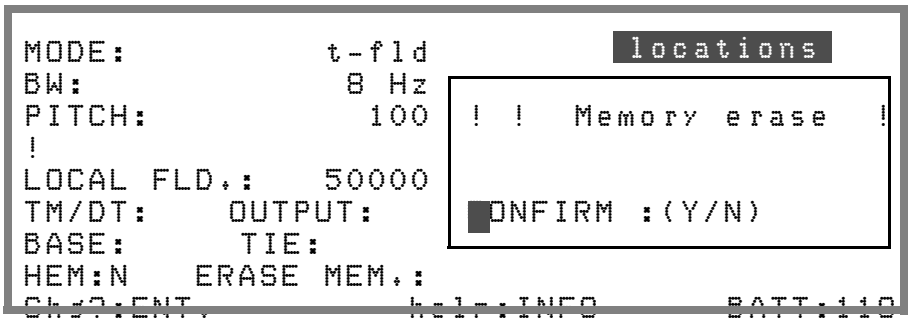
Basic mode

From the Main operating display:

1. Move the cursor to ERASE MEM:



2. Press the "ENTER" key.



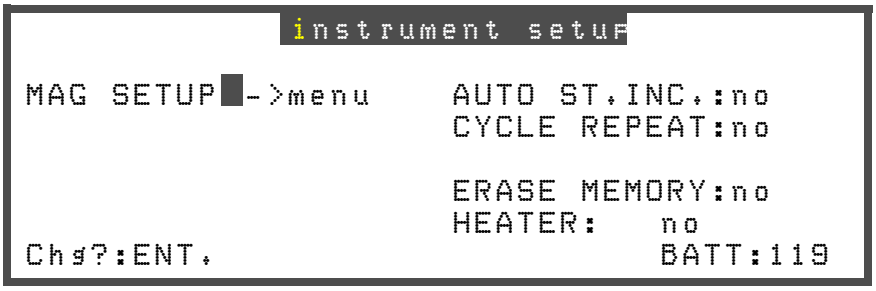
3. You will be asked to confirm that you actually want to erase all the data from memory by pressing the "Y" key. You will then see the *Block memory free* increment on the prompt line as it is cleared.

Advanced mode

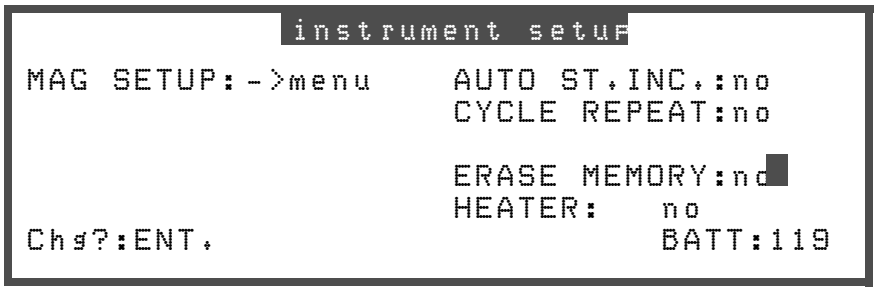
From the Main operating display:

1. **Press** the "SETUP" key.

   The INSTRUMENT SETUP display now appears:



2. **Move** the cursor to ERASE MEMORY:.
3. **Select!** YES
4. You will now see a prompt on the bottom line:
   Mem.erase! 1:DATA 2:TIE+DATA



OPTIONS:

1:DATA
This will only clear the current days data and leave any TIE-PT data in the memory for the next day's use.

2:TIE+DATA
This will clear all of the data, including the TIE-PT data.

5. You will be asked to confirm that you actually want to erase all the data from memory by pressing the "Y" key. You will then see the *Block memory free* increment on the prompt line as it is cleared.

Chapter 10

MAINTAINING YOUR SM—4/4G

GENERAL RULES

1. Keep the batteries charged at all times.
   - ▲ Charge the battery belt as soon as you receive your instrument.
   - ▲ Fully charge the battery belt when finished operating the instrument. Batteries left in a discharged state for too long will lose their capacity.
   - ▲ Charge the battery belt occasionally if it is in storage. The batteries should not be allowed to discharge below 10 volts. Ensure that the switch in the battery belt is in the *Off* position when not in use.

2. Replace the batteries in the battery belt when they lose capacity. Batteries used in what is called a *cyclic mode*, that is they are charged and then used until they lose their charge, have a limited lifetime. This is true for all lead acid batteries used with portable instrumentation. Battery life depends on several factors, with the following being the most important; how many times the batteries are fully discharged, how fully the batteries are charged after discharge, how quickly the batteries are charged after use and the ambient temperature. Your batteries may last 1 to 5 years depending on your use patterns.

3. Do not store any magnets with the instrument or bring any powerful magnets too close to the instrument. The instrument contains some non-magnetic metallic parts (such as stainless

steel screws) that may become magnetized. Consult SCINTREX if you believe that some parts of your instrument have become magnetized.

4. Treat the sensor head with care — avoid hitting the sensor head on any surfaces. The sensor head is robust but does not contain aligned optical components.

5. Do not turn the headphone volume control too harshly. The headset has been designed to operate in the rain so the contents of each cup are thoroughly sealed. Repairs are therefore labour intensive.

CHARGING THE BATTERY BELT BATTERIES

The battery belt battery charger (part no.400 151) may be identified by its 4-pin KPT connector (olive coloured, military connector). This connector mates with the connector on the box in the battery belt.

1. In order to charge the batteries, connect the battery charger and turn the 3-position switch in the battery belt to the OFF/CHRG position. The batteries will only charge with the switch in this position. The battery charger is auto switching for 115 and 230 volts AC mains supply.

2. When charging begins, the Red LED on the battery charger will light.

3. When the batteries have fully charged, the Green LED on the battery charger will light.

CONSOLE BATTERY CHARGING

The SMARTMAG console uses lead-acid batteries. These are a reliable power source when properly maintained. They can provide power through a few hundred charge/discharge cycles. However, the main source of trouble with these batteries is *deep discharge*. This occurs when the battery is fully discharged and left discharged for an extended period.

To prevent deep discharge in the SMARTMAG, electronic circuitry monitors the battery voltage and shuts the instrument down when the battery has reached its lower operating level. It should then be recharged as soon as possible. However, the instrument draws a small current even when turned off. If the SMARTMAG is left in a discharged state, for even a few days, then the battery will eventually deep discharge. Once this has happened, you will need to replace the deep-discharged battery with a new one (SCINTREX part no. 400 078 or 400 080).

Warning: The small current drain just mentioned above, is the reason why the battery **MUST BE DISCONNECTED FOR SHIPMENT AND STORAGE**. Batteries also self discharge slowly, and must be recharged periodically, e.g. every three months, even when in storage. Finally, batteries should also be stored at room temperature, or as close to it as possible.

Up to two batteries can be charged at the same time. If high capacity batteries are charged, such as those used in the External Heavy Duty Battery Pack, it is important that the charging begin right after work and continue over night.

Optimum charging takes place at room temperature. Provision is made to compensate for variation in temperature in the 0° to 40° Celsius temperature range. The battery and console should also be at the same temperature.

To charge the batteries proceed as follows.

ONE BATTERY

1. Connect the charger to the power outlet. Adjustment for different line voltages are made automatically.
2. Connect the charger to the charger input connector.
3. Flip the switch on the charger to **On**.
4. Observe the charging light at the left hand side of the SMARTMAG console. It will be **On** while charging at a high rate and turn **Off** when the battery is nearly charged.

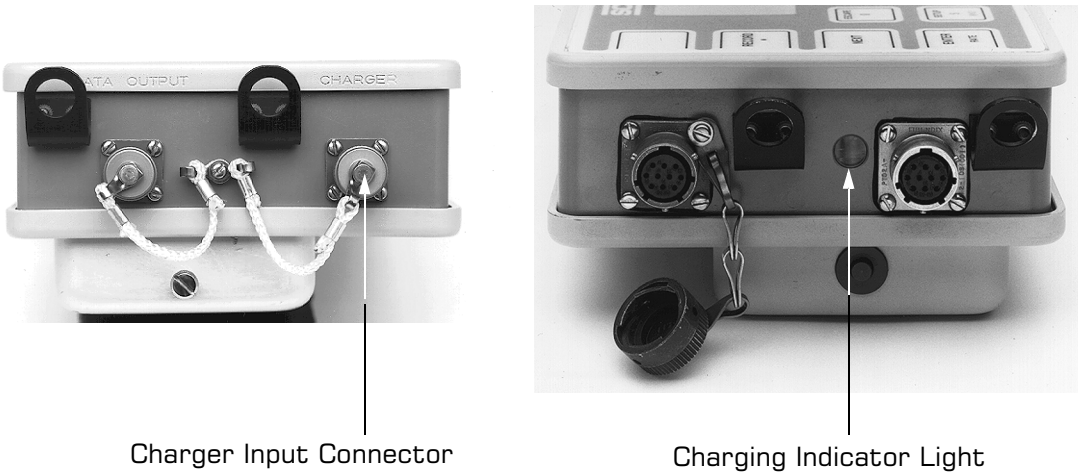


Figure 43 Charger port and charging light.

TWO BATTERIES

1. Place the console, face down, onto a flat smooth surface.
2. Unscrew the knurled screws on each side of the battery cover and lift off the cover.
3. Connect the spare battery to the AUX. CHARGER OUTPUT connector. Either side of the plug may be on top.
4. Connect the charger to the power outlet. Adjustments for different line voltages are made *automatically*.
5. Connect the charger to the charger input connector.
6. Flip the switch on the charger to **On**.
7. Observe the charging light at the left hand side of the SMARTMAG console. It will be **On** while charging at a high rate and turn **Off** when the battery is nearly charged.

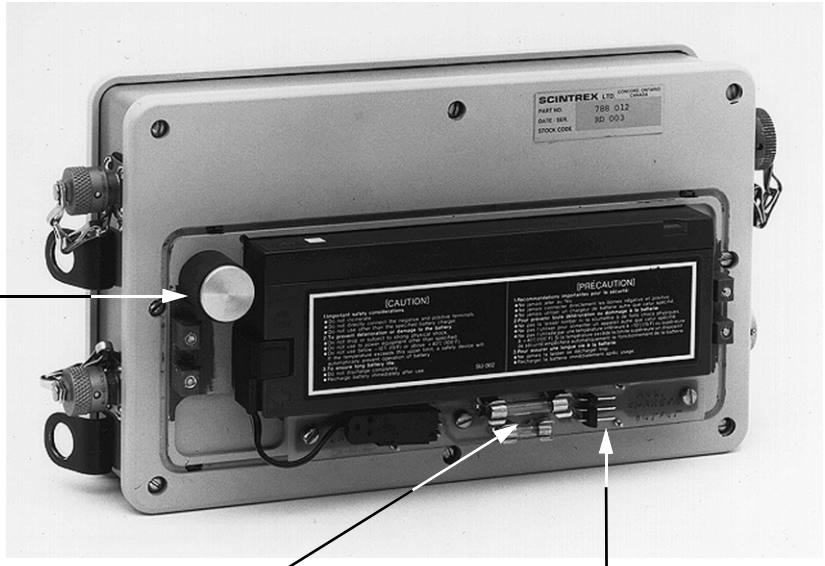


Figure 44 Location of the auxiliary charger output connector, fuse and desiccant cartridge.

PERIODIC MAINTENANCE

DESICCANT EXCHANGE

Small amounts of moisture may possibly enter the SMARTMAG console, even though it is fully sealed. A cartridge filled with a drying agent (desiccant) is located under the battery cover, refer to Figure 43 on page 10–5 for the exact location. The desiccant should be dried out periodically as required. A spare cartridge is supplied as part of the Minor Spare Parts Kit.

To dry out the cartridge:

1. Place the console, face down, onto a flat smooth surface.
2. Unscrew the screws at both sides of the battery cover.
3. Lift off the cover.
4. Pull out the cylindrical plug while gently turning.
5. Place the cartridge in front of a heat source for about one hour. A hair drier is a good source of dry heat.
6. Clean the connecting surfaces on the cartridge and the access hole.
7. Replace the cartridge.
8. Replace the battery cover.

FUSE REPLACEMENT

There is one fuse located inside the battery cover and another one is under the metal cover of the External Heavy Duty Battery Pack.

Two fuses holders are provided under the battery cover of the SMART-MAG, as shown in Figure 43 on page 10–5. One is for a 1.5 A quick, standard North American fuse (SCINTREX P/N 512 018). The other fuse holder is for a 5 x 20mm European fuse.

Caution: ONLY *one* fuse may be in place at any given time.

The fuse in the External Battery Pack (SCINTREX P/N 512 049) is a standard 5 A automotive fuse.

CONSOLE DISASSEMBLY/ASSEMBLY

Warning: Disassembly of the console is strongly discouraged due to its complexity, but should disassembly of the console be required proceed as follows:

1. Place the console, face down, onto a flat smooth surface.
2. Unscrew the screws on both sides of the battery cover.
3. Lift off the cover.
4. Remove the battery.
5. Unscrew the eight screws.
6. Lift off the rear panel carefully.
7. Watch for the wires.
8. Place the panel above the instrument on the surface.
9. Turn the console over.
10. Lift off the front panel carefully.
11. Place it to the left of the console.
12. Take care of the cable.
13. Clean all connecting surfaces before re-assembly, including the O-rings under the eight screws.
14. Make sure that the wires coming from the power connector located at the bottom left hand side of the display module are placed side by side and that all other wiring is placed such as not to get pinched.
15. Repeat steps **1** to **12** in reverse order to re-assemble the console.
16. If available, apply a small amount of oil or grease to the O-rings.
17. Tighten up the screws with a medium-sized *slotted* screwdriver. Do *not* overtighten.

CABLE REPAIR

Cables may occasionally need repair as conductors eventually break due to flexing. Some connectors are sealed with a silicon compound to prevent the entry of water and dirt. The sealing material can be removed after the cable clamp has been unscrewed to get access to the pins. It is a good practice to tape up the connector again when repaired. The proper connections are indicated in the following table:

Cable	Plug 1 Pins	Plug 2 Pins	
Total Sensor (759 513)	Field repair not recommended		
Gradiometer Sensor (759 513)	Field repair not recommended		
RS-232 (Console to Battery belt) (759 514)	A	A	Shield
	B	B	Black
	C	C	Clear
RS-232 (Console to PC) (745 081)	n/a	1	Shorted
	n/a	7	
	n/a	8	
	n/a	4	Shorted
	n/a	6	
	B	3	Tx
	C	2	Rx
	A	5	SGND
	#4 Ring Lug	Shell	PGND

SENSOR TROUBLESHOOTING GUIDE

Symptom	What to do
If the instrument appears to have power but does not seem to be able to provide a proper magnetic field value.	**1.** The instrument may not be set properly for either northern or southern hemisphere. If you are operating in the northern hemisphere (Canada, USA, Japan etc.) select 'north' via the detachable LED display and keypad. Otherwise, select 'South'. The default power up setting of the SMARTMAG is for northern hemisphere operation. **2.** The fuse on the staff assembly may be blown. This fuse is accessed by removing the small aluminum knob on the face plate at the end of the staff. No disassembly is required to gain access to this.
If the instrument does not seem to have any power.	**1.** The batteries may be discharged. Connect the battery charger to the battery charger connector on the box in the battery belt. The switch on the same box must be set to the *Charge* or *Off* position (CHRG/OFF) for the charger to operate. **2.** The fuse may be blown in the box in the battery belt. If the batteries are fully charged (12 volts) but the LED on the box does not light when the switch is set to the *On* position, then the fuse in the box may be blown. To gain access to the fuse, remove the four screws holding the lid onto the box. The fuse may be replaced with a 5 or 6 amp slo-blo fuse. Spares are provided with each unit.
If the battery belt does not seem to charge the batteries.	**1.** In order to charge the battery belt batteries, the 3-position switch in the belt must be switched to the OFF/CHRG position. **2.** If the batteries are discharged below 8 volts, some early versions of the battery charger may not charge them as a safety measure. Verify that the batteries are discharged below 8 volts by using a voltmeter. Remove the batteries from the belt and connect each battery to a 12 volt DC power supply until they are charged above 8 volts (at which point the battery charger should then be used). When using a DC power supply to charge the batteries, the current should be limited by inserting a 50 ohm, 5 watt resistor in series with the battery. Note that the batteries that have been so deeply discharged may be damaged and should be replaced if they no longer have a usable storage capacity.

CONSOLE TROUBLESHOOTING GUIDE

Problems	Possible Causes	Possible Solutions
On/Off key does not respond (no beep)	Battery not connected	Install battery
	Battery discharged	Charge battery
	Fuse blown	Disconnect sensor. Check and replace fuse in the battery compartment or in the External battery pack depending on which one you are using.
Instrument shuts off immediately	Low battery	Charge battery.
Fuse blows after the start of a reading	Short circuit in sensor cable	Repair sensor cable.
Display is very slow	Display is too cold	Turn on the LCD heater, using the AUX/LCD button to access option, if the ambient temperature is below minus 15° C.
Display is invisible	Incorrect LCD intensity setting	1. If no data is in the instrument, perform a cold boot. 2. Adjust LCD intensity using AUX/LCD button to access option. 3. Turn on the heater if below minus 15° C.

Problems	Possible Causes	Possible Solutions
Data does not dump	RS-232 cable not connected	Connect cable.
	Computer not communicating	1. Run the computer communications program. 2. Check that you are using the correct serial port on your computer.
	Baud rate incompatible	Set baud rates on the computer and SMARTMAG console to be identical.
	No such data in instrument	1. Make sure that you are asking for data that you have measured, i.e. asking for base or grad when t-fld recorded. 2. Select: dump all records.
	No matching line number	Set proper line number or disable line by line dump.
Base-station correction does not work	Base unit and mobile unit not properly interconnected.	Interconnect units via Null Modem.
	No matching date or time	Correction must be made externally on a computer.
Cannot recall data	No respective line or station (or time, if base-station).	Set recall parameters to match survey parameters, i.e. LN, SEP, STN, SEP may be out a digit.

Chapter 11

REFERENCE INFORMATION

SMARTMAG TECHNICAL SPECIFICATIONS

Operating Principles:	Self-oscillating split-beam Cesium Vapour (non-radioactive Cs–133)
Operating Range:	15,000 to 100,000 nT
Gradient Tolerance:	1,000 nT/inch 40,000 nT/metre
Sensitivity:	0.01 nT for all sample rates
Information Bandwidth:	<0.003 nT √Hz rms
Heading Error:	<±1 nT
Sensor Orientation:	Adjustable 0° to ±90°
Active Zone:	10° to 85° angle between sensor head and magnetic field vector.
Hemisphere Switching:	Operator selectable through software control
Sample Rate:	User selectable 1, 2, 5, 10 samples per second, sample on demand for models SM–1 and SM–2.
Data Storage:	Non-volatile RAM with 8.6 hrs of total field magnetic data, 5.3 hrs of gradiometer (at 10 samples per second).

Data Capacity:	SM–4: 310,000 readings (Total Field) 750,000 readings (Base Station) SM–4G: 190,000 readings
Audio Output:	User selectable sensitivity, DC – 15kHz output with audible clicks for low frequencies and auto baseline tracking. Non-magnetic piezoelectric headphones with volume control.
Data Output:	Digital RS–232C interface, 600 to 57,600 baud, 7 or 8 data bits, 1 start & 1 stop bit, no parity format. Selectable carriage return delay (0 – 999ms) to accommodate slow peripherals. Handshaking is done via XON/XOFF. High speed binary dump. Analog 0-999mV full scale output with keyboard selectable range of 1, 10, 100, 1000 or 10,000 full scale (models SM–4/4G only). For models SM–2 and SM–3 RS–232: 19,200 baud, 8 data, 1 stop and 1 start bit. Optional RS–422 for SM–2. High speed binary dump for model SM–3.
Visual Output:	LCD “Super Twist”, 240x64 dots graphic, 8 line x 40 characters alphanumeric with thermostatically controlled display heater for model .
Real Time Clock:	Records full date, hours, minutes and seconds with 0.1 second resolution, with ±1 second stability over 24 hours (not available for models SM–1 and SM–2). Automatic time setting from GPS via RS–232.
Console Power Supply:	Internal rechargeable ‘Camcorder’ type battery, 2.3 Ah, lead acid.
Sensor/Electronics Power Supply:	Rechargeable battery belt 2 x 12 VDC, 4 Ah lead acid.
Console Battery Charger:	110 – 230 VAC, 50/60 Hz.
Battery Belt Charger:	90 – 264 VAC, 47 – 63 Hz.

Mechanical	Sensor: 6.3cm diameter by 16cm long (2.5in diameter by 6.3in long)
	Sensor/Staff/Electronics: 1.2m (47in) in length 2.1kg (4.6lbs)
	Console: 25.4 x 15.3 x 8.4cm (10 x 6 x 3.5 in) 2.2kg (4.8lbs)
	Battery Belt: 4.4kg (9.7lbs) — Standard battery 6.4kg (14 lbs) — Heavy-duty battery
Environmental:	Operating Temperature: –30°C to +50°C (–25°F to +122°F)
	Storage Temperature: –40°C to +70°C (–40°F to +158°F)
	Water Tight: To 1m (3ft) depth (sensor head)
	Shock: Drop 1m (3ft) on a hard surface without damage

OPTIONS

- ▲ Vertical or Horizontal Gradiometer
- ▲ GPS
- ▲ Distance triggering
- ▲ Data Processing, Modelling, Interpretation and Presentation software packages
- ▲ Customized system design
- ▲ Training

INSTRUMENT PARTS LIST

Item Description	SCINTREX Part Number
SMARTMAG Model SM–4	759 003
*SMARTMAG Model SM–4G	759 004
SMARTMAG Main Assembly	759 009
RS-232 Cable Adaptor (null modem)	211 154
Rechargeable Battery Belt	759 043
110/220 VAC Battery Charger (Battery belt)	400 151
Shoulder Strap	759 504
RS-232 Cable (Console to PC)	745 081
SMARTMAG Console	759 012
Console Rechargeable Battery	400 078
110/220 VAC Console Battery Charger	400 139
SMARTMAG SM–4/4G Information Package Consisting of: SM–4/4G Operations Manual 759 704 ENVIMAP Manual 759 705 ENVIMAP Software 788 032 Magnetic Applications Guide 759 700	759 534
Transit Case	759 505
SMARTMAG Minor Spares Kit	759 039
Console Minor Spares Kit	788 030
*Gradiometer Mounting Kit	759 082

Options

Major Spare Parts Kit	759 042
Detachable Keyboard/Display	759 021
Mounting Kit for Display	759 503
Audio Output Option	759 049
Heavy Duty Rechargeable Battery Belt	759 083
Distance Triggering Option	759 081
Sensor Power Cable (Total/Gradiometer)	759 513
RS-232 Cable (Console to belt)	759 514

*SM–4G only

WARRANTY & REPAIR

WARRANTY

All SCINTREX equipment, with the exception of consumable items, is warranted against defects in materials and workmanship for a period of one year from the date of shipment from our plant. Should any defects become evident under normal use during the warranty period, SCINTREX will make the necessary repairs free of charge.

This warranty does not cover damage due to misuse or accident and may be voided if the instrument console is opened or tampered with by persons not authorized by SCINTREX.

To validate the warranty, the instrument's warranty card must be returned to SCINTREX within 30 days of shipment from our plant.

REPAIR

When to ship the unit

Please do not ship your instrument for repair until you have communicated the nature of the problem to our Customer Service Department by telephone, facsimile or correspondence. Our Customer Service Department may suggest certain simple tests or steps for you to do which may solve your problem without the time and expense incurred in shipping the instrument back to SCINTREX for repair. If the problem cannot be resolved remotely, our personnel will request that you then send the instrument to our plant for the necessary repairs.

Description of the problem

Please include the following information when describing the problem:

- the symptoms of the problem,
- how the problem started,
- if the problem is constant, intermittent or repeatable,
- if constant, under what conditions does it occur,
- any printouts demonstrating the problem.

SHIPPING INSTRUCTIONS

No instrument will be accepted for repair unless it is shipped *prepaid*. After repair, it will be returned *collect*, unless other arrangements have been made with SCINTREX. Please mention the instrument's serial number in all communications regarding equipment leased or purchased from SCINTREX.

Warning: Please do not ship the instrument with the batteries installed.
FURTHER DAMAGE MAY RESULT!

U.S.A.

Instruments for repair in the United States should be shipped to:

SCINTREX
525 Fort Worth Drive, Unit 216
Denton, Texas 76201

Canada

Instruments within Canada should be shipped to:

SCINTREX Limited
222 Snidercroft Road
Concord, ON L4K 1B5

Outside Canada and the U.S.A.

Instruments shipped for repair from outside Canada and the U.S.A. should be addressed to SCINTREX and shipped with the appropriate customs documents to:

SCINTREX
c/o Danzas
Lester B Pearson (Toronto) International Airport
Toronto AMF, CANADA

Customs documents

Three sets of customs documents must be included:

- one set inside of the package,
- one set attached and sealed to the outside of the package,
- one set attached to the air waybill.

SCINTREX instruments are manufactured in Canada, consequently there is no customer duty payable in Canada. It is advisable to state on the customs documents the following:

- **"Canadian Goods Returned to Canada for Repair"**
- **Name of the equipment**
- **Value**
- **Serial Number**
- **Reason for return**
- **Packaging and weight**

ORIENTING CESIUM SENSORS FOR BEST PERFORMANCE

INTRODUCTION

The SMARTMAG is a cesium vapour, optically pumped self-oscillating magnetometer. If it is properly oriented inside its active operating zone, it will start oscillating shortly after it is turned on. The warm-up time is determined by the time required for the electronically controlled heaters to bring the absorption cell and the cesium lamp to the proper operating temperature. The warm-up is over in few minutes after a cold start. If the operating temperature is already established, it takes only a few milli-seconds for the magnetometer to start oscillating after turn-on or after an orientation change from a dead zone into the active zone. A self-oscillating magnetometer can track extremely large and fast magnetic field changes without stopping oscillating.

The frequency of oscillation is called the Larmor frequency. The Larmor frequency is proportional to the magnitude of the ambient magnetic field. The constant of proportionality that relates the magnitude of the ambient magnetic field to the Larmor frequency is known as the gyromagnetic constant and for cesium 133 it equals 3.498577Hz/nT.

An ideal magnetometer placed in a constant field should produce a constant frequency. A real optically pumped magnetometer, regardless of which element it uses for its operation (cesium, rubidium, potassium or helium), and regardless of which principle of operation it employs (self oscillating, locked oscillator), produces a frequency which varies because: a) the unavoidable sensor noise makes the frequency jitter

around the correct frequency and b) the output frequency is somewhat dependent on the magnetometer orientation. The later dependency gives rise to the so called heading error. Both, the magnetometer noise and the heading error, are low due to proper design and careful alignment of the magnetometer. Precautions should be taken that they are sustained low by properly orienting the magnetometer sensor inside the operating active zone. The recommendations of how to achieve this, without restrictions to the established survey practices, are the subject of this section.

THE ACTIVE ZONE OF THE SMARTMAG

Figure A–1 indicates that the sensor head assembly has a so called optical axis which has a direction as shown in the diagram. The angle between the positive direction of the optical axis and the direction of the magnetic field, H_o, is called the *tumble angle* . In a self-oscillating magnetometer, like the SMARTMAG, there is no Larmor signal generated if the optical axis is parallel to the magnetic field (the polar orientation, 0^o or 180^o) or perpendicular to the field (the equatorial orientation, 90^o). The optical signal amplitude increases quite rapidly outside those two orientations, and it has a broad maximum around 40^o or 140^o . Note, that the Larmor signal amplitude generated inside the sensor head is not to be confused with the RS-232 output of some of the SMARTMAG models.

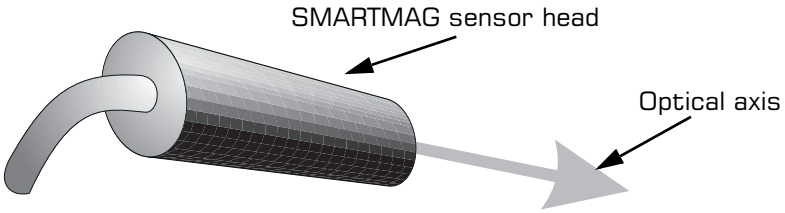


Figure A—1 Sensor optical axis

Experimental results confirm that the SMARTMAG will perform satisfactorily when the angle is from:

$$10^{o} < \theta < 85^{o} \quad \textbf{(1)}$$

and from

$$105^{o} < \theta < 170^{o} \quad \textbf{(2)}$$

Equation (1) covers the magnetometer's active zone in the northern operating hemisphere. This active zone is depicted in Figure A–2 on page A–4. The measured magnetic field could be anywhere inside the space bound by the northern polar dead zone cone and the equatorial dead zone *disk*. Note, that the polar sensor orientation occurs when the sensor optical axis is parallel with the ambient magnetic field. In the northern polar orientation, the magnetic field and the sensor optical axis point in the same direction (0^{o}). In the southern polar orientation, they point in the opposite directions (180^{o}). The equatorial orientation occurs when the optical axis is perpendicular to the ambient magnetic field (90^{o}). Relationship **(2)** covers the magnetometer's active zone in the southern operating hemisphere. This active zone is depicted in Figure A–3. The magnetic field could be anywhere inside the space bound by the southern polar dead zone and the equatorial dead zone.

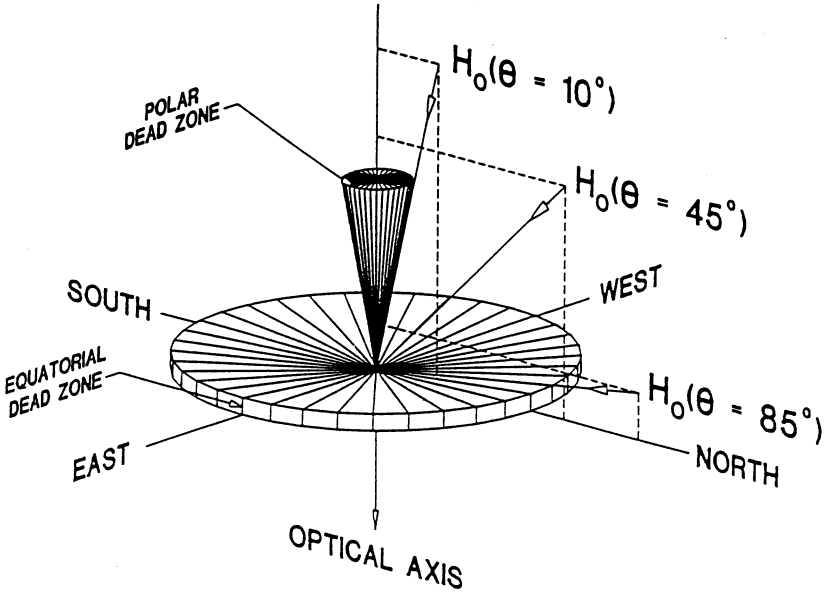


Figure A—2 Active zone in northern operating hemisphere

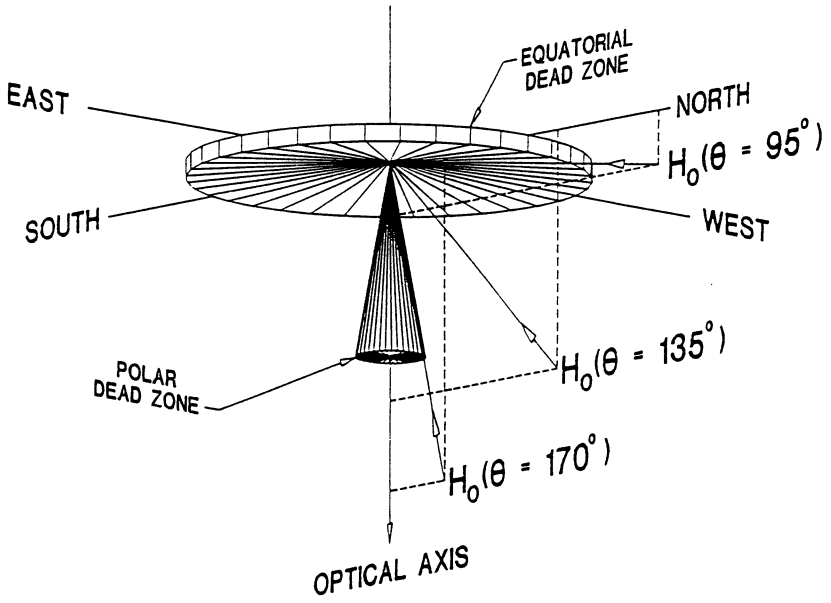


Figure A—3 Active zone in southern operating hemisphere

The magnetic field vector is pointing into the ground in the Earth's northern magnetic hemisphere and out from the ground in the Earth's southern magnetic hemisphere. It is parallel with the ground at the Earth's magnetic equator. Note, that neither the Earth's geographic and magnetic poles nor the equators exactly coincide, as it can be seen in Figure A–4 on page A–6.

Software Hemisphere Switching of the SMARTMAG allows setting of the electronics for the proper operation in either the northern or southern operating hemisphere.

Inside its operating range the SMARTMAG performance is good, in regard to measurement noise and heading errors. The measurement noise starts to increase appreciably only when the magnetometer orientation comes close to the boundary of the operating range given by realtionships **(1)** and **(2)**. It is about three times larger at the boundary

of the operating range than it is at a broad minimum centered around the middle of the operating zone. It is about twice as large 5^o away from the boundary of the operating zone.

Equally, the heading errors are low inside most of the operating zone, and increase somewhat faster close to the polar dead zones. *Note that the actual dead zones are very narrow: the polar dead zone cone is ±6^o wide and the equatorial dead zone disk is only 3^o wide inside each operating hemisphere.* The actual operating zone is several degrees larger than indicated by relationships **(1)** and **(2)**.

CALCULATION OF THE TUMBLE ANGLE

The SMARTMAG sensor orientation is determined by two angles:

1. the *sensor azimuth*, α , defined as the angle in the horizontal plane between the horizontal projection of the sensor optical axis direction and the direction of the magnetic north, and
2. the *magnetometer sensor inclination*, β , defined as the angle in the vertical plane between the horizontal line and the magnetometer optical axis.

The *ambient magnetic field inclination*, γ , is defined as the angle between the horizontal and the field direction. The Earth's magnetic field inclination is a positive angle ranging from 0^o to 90^o in the Earth's Northern Magnetic Hemisphere and negative angle in the Southern Hemisphere. Its dependance on the geographic location is shown in Figure A–4 on page A–6.

For a given sensor orientation and magnetic field inclination, the angle between the sensor and the magnetic field, i.e. the *tumble angle*, θ , can be calculated from the following equation

$$\theta = \mathrm{acos}(\cos\alpha\cos\beta\cos\gamma\sin\beta\sin\gamma) \qquad \textbf{(3)}$$

This equation can be used to find out whether the magnetometer sensor is inside its active zones specified by relationships **(1)** and **(2)**. It is a good idea to reduce the operating active zone by the amount of the anticipated aircraft motion. In general, airborne magnetic surveys are

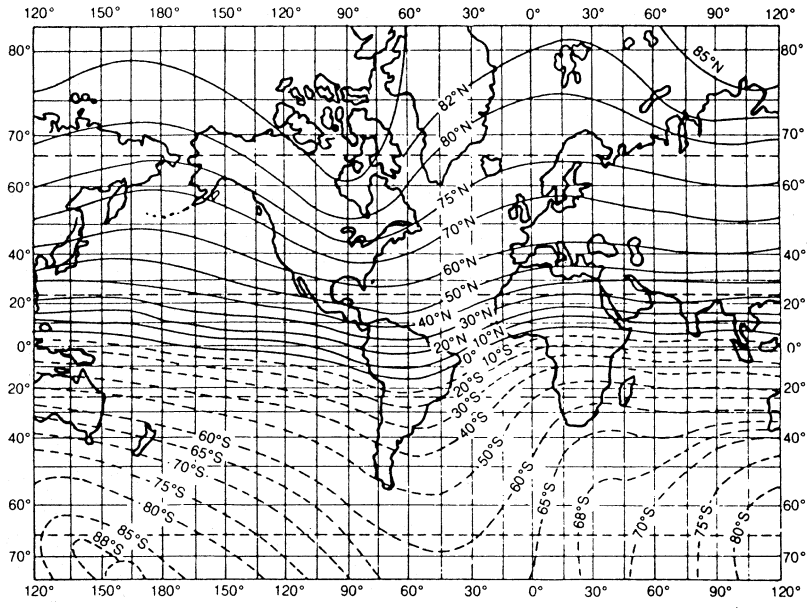


Figure A—4 Inclination of the Earth's ambient magnetic field.

conducted in calmer weather to keep the aircraft motion to within 5^{O} in pitch, roll and yaw. In such case, with the additional allowance we must orient the magnetometer sensor so that the tumble angle satisfies in the northern operating hemisphere the relationship

$$15^{O} > \theta > 80^{O} \quad \textbf{(4)}$$

and in the southern operating hemisphere the relationship

$$100^{O} > \theta > 165^{O} \quad \textbf{(5)}$$

Note: Inside this operating zone the magnetometer noise will not increase more than a factor of two from the minimum value at 40^{O} or 140^{O} and the heading error will be inside the specified limits.

As it will be seen in the next section, orienting the SMARTMAG is simple: *with only two settings one can survey the entire Earth's surface*. However, in order to gain more insight, the tumble angle, equation **(3)** is evaluat-

ed over the entire range of the magnetic field inclinations for two sets of sensor azimuths and five values of sensor inclinations. The results are shown on the graphs in Figure A–5 on page A–9 to Figure A–13 on page A–13.

Tumble angles from 0^o to 90^o indicate that the magnetometer has to be set for operation in the northern operating hemisphere. Tumble angles from 90^o to 180^o indicate that the magnetometer has to be set for operation in the southern operating hemisphere. In accordance with the realtionships **(4)** and **(5)**, the polar dead zones are from 0^o to 15^o and from 165^o to 180^o. The equatorial dead zones are from 80^o to 100^o. The azimuth values in each set differ by 90^o, to comply with the requirement that both the flight lines and the perpendicular tie lines are flown in two opposite directions. The sensor inclination should be selected so that the sensor will not be in any of dead zones for either one of these four azimuths and over the range of magnetic field inclinations expected in the surveyed area. Comments on advantages and disadvantages of five representative sensor orientations follow:

a) Sensor inclination 90^o:

From the graph in Figure A–5 on page A–9 one could determine the value of the tumble angle (the angle between the magnetic field and the sensor optical axis) for all possible values of the magnetic field inclination. Because the sensor is vertical, the tumble angle is *independent* of the sensor azimuth (one curve is valid for all azimuths). The operating range of the magnetic field inclinations, for which the tumble angle is inside the active operating zone, is indicated by horizontal arrows in the graph. The sensor orientation shown in the Figure A–5 is very useful because it covers most of the Earth's surface with the exception of polar and equatorial regions.

b) Sensor inclination 67.5^o:

Sensor azimuth values used in Figure A–6 on page A–10 are 0, 90, 180 and 270 degrees. Please note, that the sensor azimuth may differ from the flight direction azimuth, as the sensor axis may have to be set out of the airplane axis. For example, if the line (flight) direction is NE, and the sensor azimuth is to be 90^o, then the sensor axis is to be rotated by

45° clockwise from the airplane axis. The particular sensor orientation shown in Figure A–6 does not offer any advantages. A more advantageous orientation is one with the same sensor inclination, but different azimuths, Figure A–7 on page A–10. Large areas extending from either pole down to the field inclination of 25° could be surveyed using this orientation. However, the operation is at the edge of the active zone for the magnetic field inclinations around ±75°.

c) Sensor inclination 47.5°:

Tumble angles for the sensor azimuths parallel or perpendicular to the magnetic field direction could be determined from the graph in Figure A–8 on page A–11. This orientation could be used in surveying polar regions. If the azimuth of 90° and 270° are used for flying normal survey lines, the tumble angle is same for both up-the-line and down-the-line flying, and it is well inside the active zone. The sensor orientation shown in Figure A–9 on page A–11 offers the advantage of use for surveys in ether polar or equatorial regions. Please note that, when flying in equatorial regions, the sensor operating hemisphere has to be changed from north to south when the flight direction on either normal or tie survey lines, is changed. The same applies for any other orientation used for surveying in equatorial magnetic field regions. For the completeness, the orientation with azimuths between those shown in Figures A–8 and A–9 is shown in Figure A–10 on page A–12. As it can be seen, it does not offer any additional advantages.

d) Sensor inclination 22.5°:

The orientation shown in Figure A–11 on page A–12 does not offer any advantages. The orientation in Figure A–12 on page A–13 offers, in comparison with the orientation in Figure A–9 on page A–11, an extension of surveying into regions well away from the magnetic equator at the expense of reduction in the polar regions.

e) Sensor inclination 0°:

Calculation of the tumble angle

The orientation in Figure A–13 on page A–13 is not acceptable, as the tie lines are in dead zones. The orientation shown in Figure A–14 on page A–14 has the advantage of covering the entire Earth except the polar regions. For large area, up to the field inclination of ±45°, the sensor operates far from the dead zones, but the sensor operating hemisphere has to be changed when the flight direction is reversed.

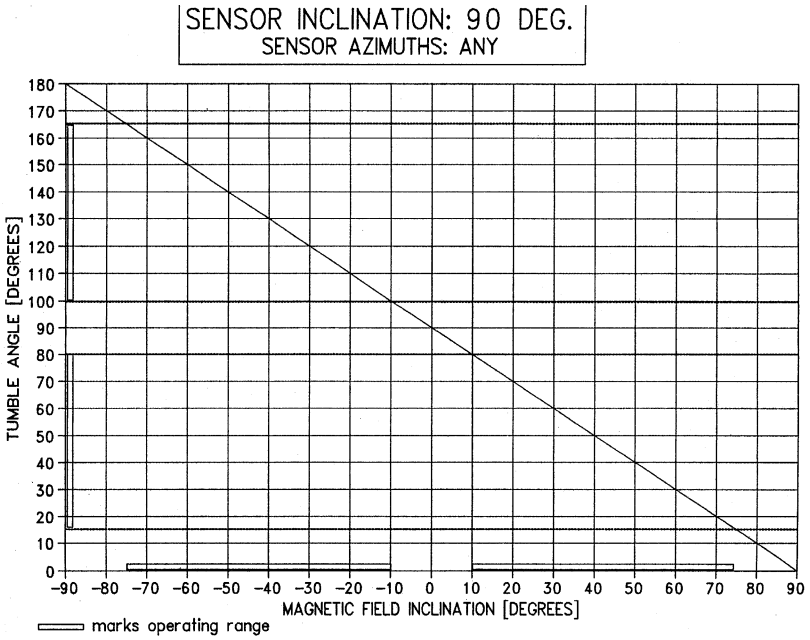


Figure A—5 Sensor inclination at 90°

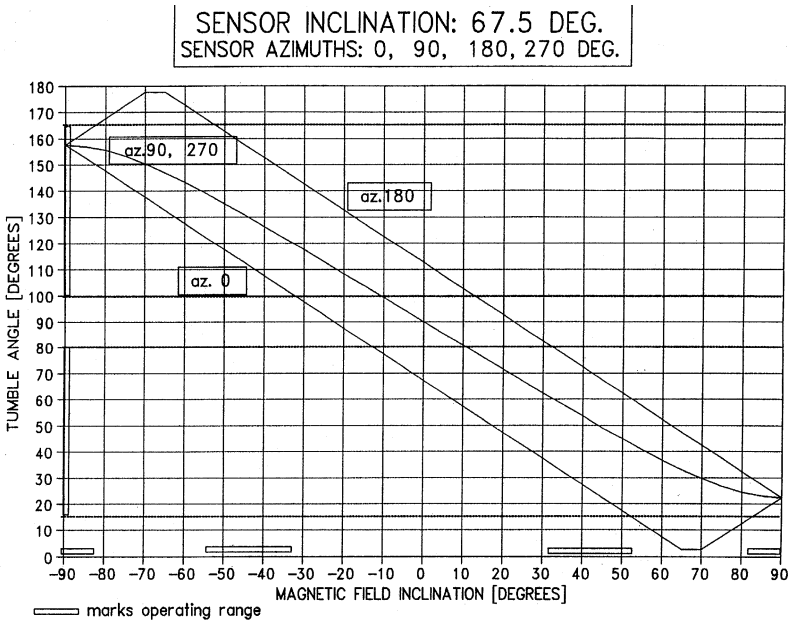


Figure A—6 Sensor inclination 67.5°

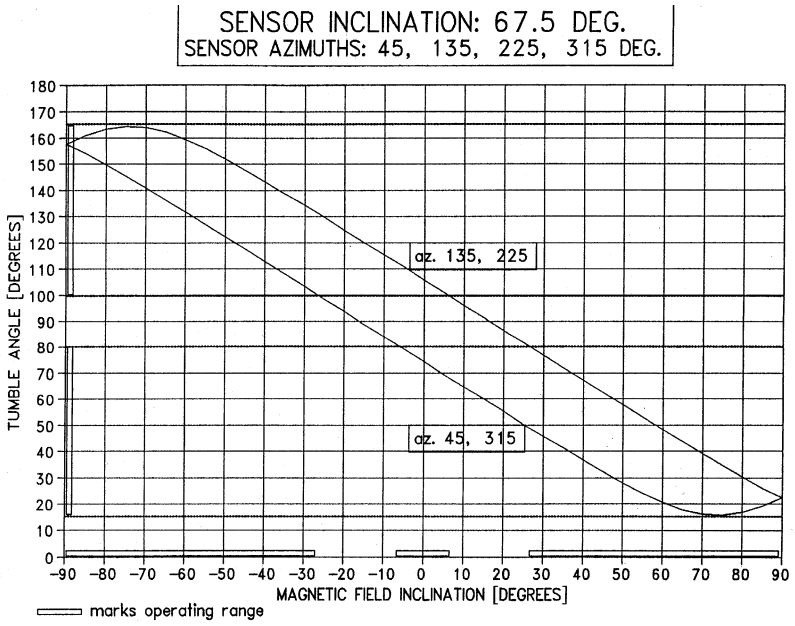


Figure A—7 Sensor inclination 67.5°

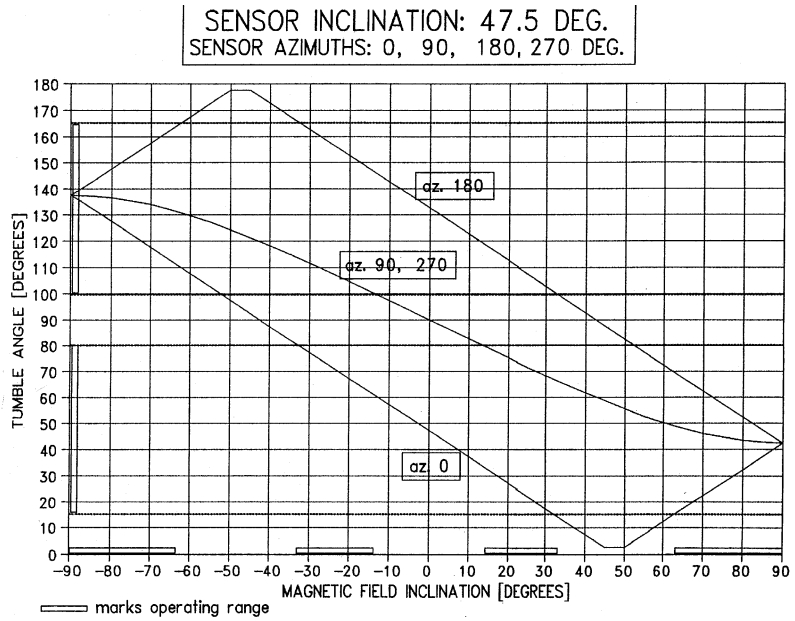


Figure A—8 Sensor inclination 47.5°

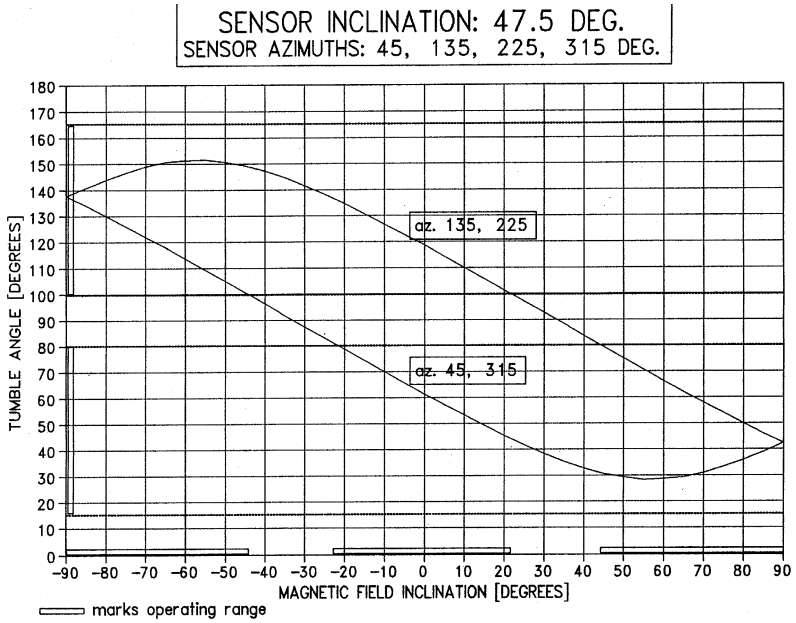


Figure A—9 Sensor inclination 47.5°

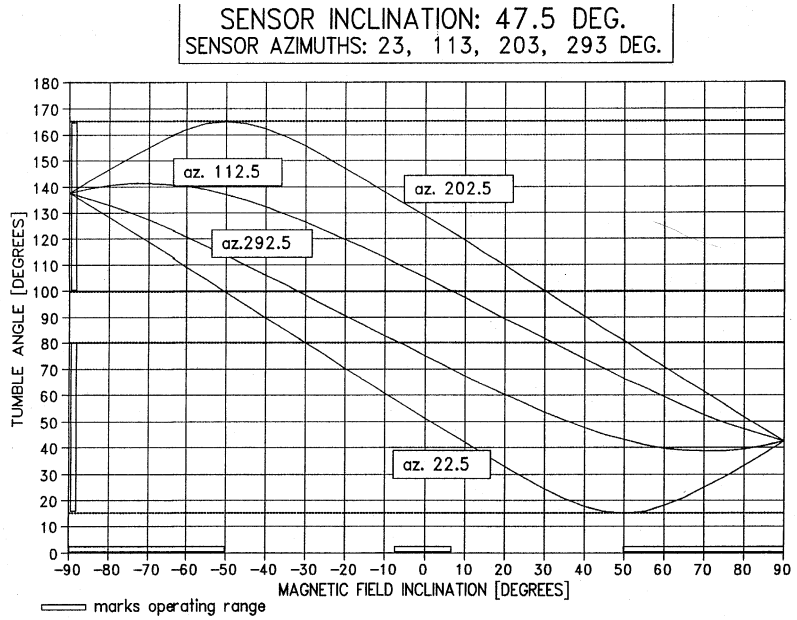


Figure A—10 Sensor inclination 47.5°

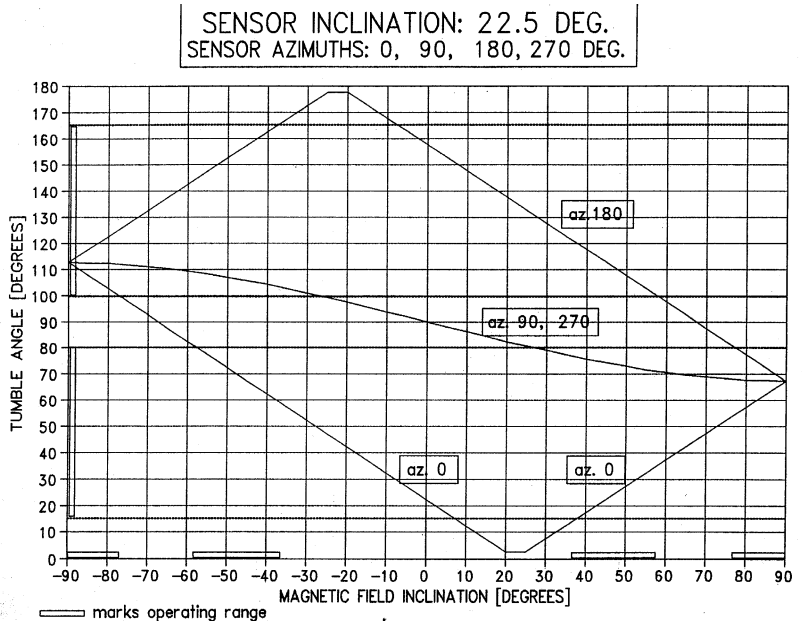


Figure A—11 Sensor inclination 22.5°

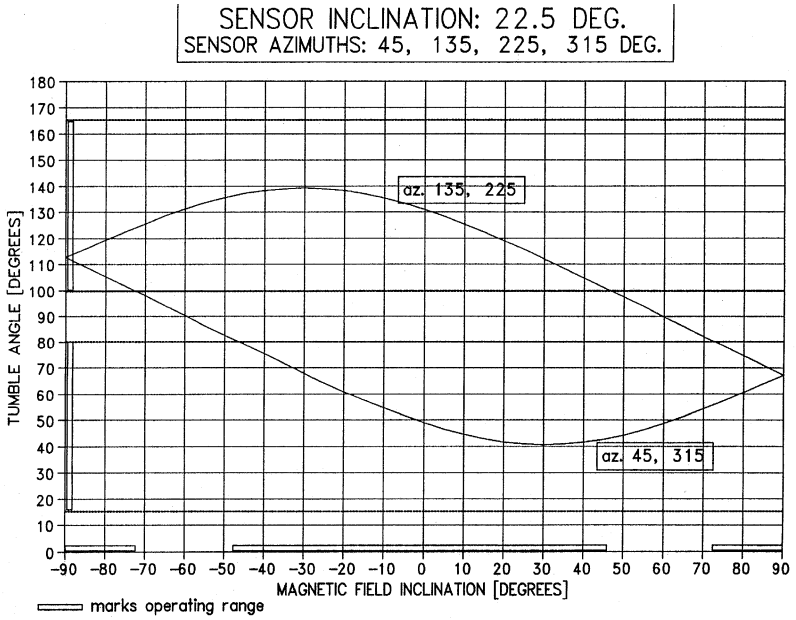


Figure A—12 Sensor inclination 22.5°

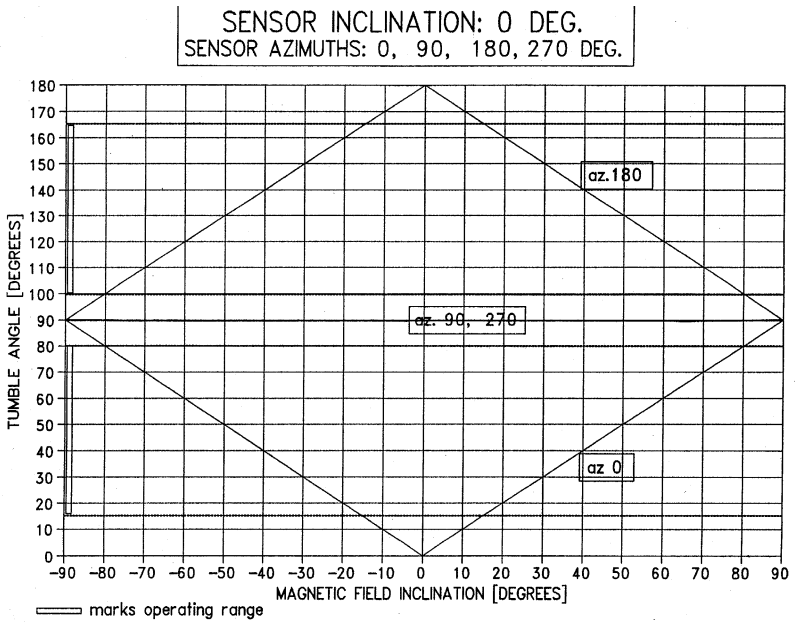


Figure A—13 Sensor inclination 0°

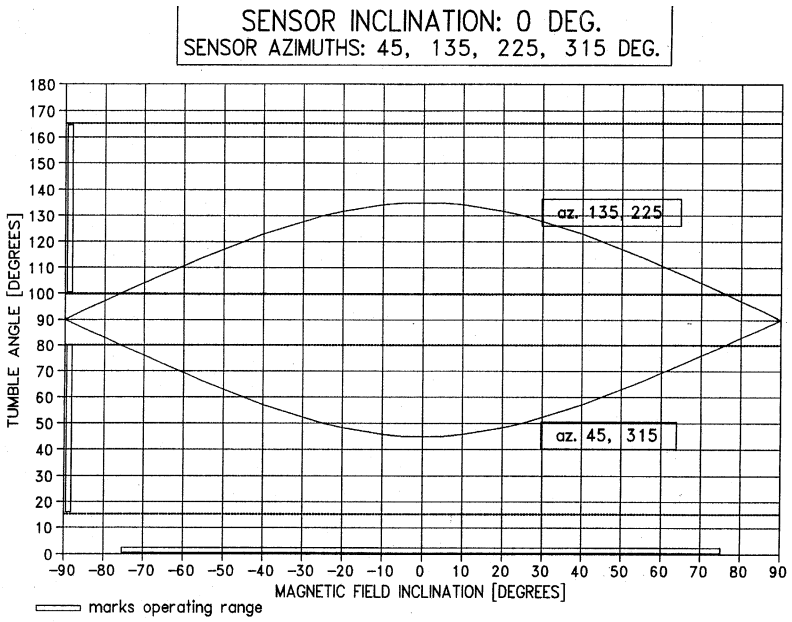


Figure A—14 Sensor inclination 0°

RECOMMENDED SENSOR ORIENTATIONS

Only two orientations are sufficient for surveying along two sets of perpendicular lines over the entire Earth's surface:

Orientation 1–the orientation in Figure A–9 on page A–11, with the sensor inclination 45° and azimuths 45, 135, 225, 315 degrees, for polar and equatorial regions.

Orientation 2–the orientation in Figure A–5 on page A–9, with sensor inclination 90 degrees, for the regions between polar and equatorial regions. These orientations provide enough overlap at both ends: regions with field inclinations N/S from 53° to 75° and inclinations N/S from 10° to 22° could be surveyed by either sensor Orientation 1 or Orientation 2.

In the overlap regions the tumble angle comes close to boundary of the dead zones. *For a larger safety margin following alternate orientation is strongly recommended:*

Orientation 3–The operation around the magnetic equator, extending well into the regions with the magnetic field inclinations up to 45°, could be covered with the sensor inclination 0° and azimuths 45, 135, 225, 315 degrees, Figure A–14 on page A–14.

If the above three orientations are used in both Earth's magnetic hemispheres as follows:

1. Orientation 1 for the field inclinations from 60° to 90°
2. Orientation 2 for the field inclinations from 35° to 60°
3. Orientation 3 for the field inclinations from 0° to 35°

then:

a. the minimum safety margin to the boundary of the operating range is 14° and it will occur for the field inclination 62°

b. the safety margin less than 15° will occur only for the range of the field inclinations from 60° to 65°

c. the safety margin less than 20° will occur for the range of the field inclinations from 55° to 78°.

Note: The additional allowance of 5° has been already subtracted from the essential operating range specified by relationships **(1)** and Table 2 on page A–3 to arrive at the reduced operating range, relationships **(4)** and **(5)** on page A–6 (for which the above analysis applies).

Index

Numerics

12-Volt battery 2–10

A

AC-power 2–10
Active zone A–2
    northern hemisphere A–3
    southern hemisphere A–4
Adjusting
    sensor head angle 3–4
Advanced mode 6–1, 6–20, 7–14
    Auxiliary display 6–33
    configuration displays 6–20
    Data collection displays 6–26
    data output display 6–34
    data output procedures 9–10
    Data output setup 9–10
    Display intensity control 7–25
    Dumping data 9–12
    Erasing memory 9–16
    graphic data display 6–28
    INFO display 6–38
    Locking parameters 7–26
    Main operating display 6–20
    NOTES display 6–37
    Numeric data display 6–26
    parameters 6–20
    recall displays 6–29
    Reprogramming op. system 7–27
    Sample base-station setup 7–18
    Sample INFO display setup 7–21
    Sample Instrument setup 7–14
    Sample Note entry 7–23
    Search mode setup 8–13
    setup display 6–23
    Tie-point correction procedure 8–19
    unlocking parameters 7–26
Alphanumeric
    input 6–7, 7–6
Ambient magnetic field 6–23
Archaeology 6–12
Assembling
    SM–4 4–2
    SM–4G 5–2
Assembly 2–3
Audio function
    SM–4 4–6
    SM–4G 5–7
Audio option kit
    installing 2–6
AUTO RECORD
    advanced 6–25
Automatic
    station increment 6–22
    tuning 7–15
    turn-off 6–9
AUX/LCD key 6–5, 6–33
Auxiliary display 6–33
Auxiliary functions display 6–5

B

Bandwidth
    setting for SM–4 4–6
    setting for SM–4G 5–7
BASE
    basic 6–14
BASE CORRECT
    advanced 6–24
BASE FIELD
    advanced 6–25
Base-station 8–3
    correction procedure 8–14
    operation 8–10

sample setup 7–18
setup
advanced mode example 7–18
Basic mode 6–1, 7–9
data collection display 6–16
datat output procedures 9–9
Erasing memory 9–15
Output format XYZ++ 9–4
parameters 6–13
Sample total-field setup 7–9
Tie-point correction 8–18
BATT
basic 6–16
Batteries
Charging battery belt 10–2
Battery 6–3
12-Volt external 2–10
car 2–10
compartment 6–3
console installation 2–7
cyclic mode use 10–1
deep discharge 2–7, 10–3
External Pack 2–8
life 10–1
removal for shipping and storage 2–2
Battery belt
charging batteries 10–2
connecting sensor assembly 2–4
installing 2–3
Battery charging
console 10–3
single battery 10–4
two batteries 10–5
Baud rate 6–35
Beeper port 6–7
BINARY 9–7
Blank display
function SM–4 4–5
function SM–4G 5–6
Blocks (sub-pages) 6–9
Buried Ordnance Detection 6–12
BW
basic 6–13
search 6–18
BW (bandwidth) 6–23

C

Cable
repair 10–9
Cables
connecting 4–2
connecting gradiometer 5–3
Calculating
tumble angle A–5
Car battery 2–10
Carrying strap 6–3
Cartesian co-ordinates 6–15, 6–20, 6–21
Changing parameters 7–5
Character input 6–7
Charger connector 6–3
Charging
battery belt 10–2
Charging light 6–3
CHART SCALE
advanced 6–24
CLEAR key 7–6
Clearing memory 9–15
Cold boot 1–2, 7–1, 7–2
Components
SM–4 4–2
SM–4G 5–2
Configuration displays
Basic mode 6–12
Configuration menu 7–3
Connecting
cables 4–2
gradiometer cables 5–3
Connector
charger 6–3
data output 6–3
external power 6–3
sensor 6–3
Console

AUX/LCD key 6–5
battery charging 10–3
battery installation 2–7
beeper port 6–7
cursor keys 6–5
description 6–3
disassembly 10–8
ENTER key 6–5
ESCAPE key 6–5
INFO key 6–6
key functions 6–5
minus (–) key 6–7
NEXT key 6–6
NOTE key 6–6
NUM/GRA key 6–6
ON/OFF key 6–5
plus (+) key 6–7
RECALL key 6–6
RECORD key 6–6
TIE-PT key 6–6
troubleshooting 10–11
Conventions
typeface xv
Converting
binary data 9–7
Correction
base-station
using 8–14
procedures, survey 8–14
tie-line 6–24
tie-point 6–6
tie-point procedures 8–18
Cursor keys 6–5
Cycle
repeat 6–22
CYCLE REPEAT
advanced 6–22
CYCLE TIME
advanced 6–24
Cyclic mode
battery use 10–1

D

Data
converting binary 9–7
erasing 9–15
Data bits 6–35
Data collection displays
Advanced mode 6–26
Basic mode 6–16
Data dumping 6–34
Data output 9–1
connector 6–3
Display (advanced mode) 6–34
format 6–35, 6–36
Formats 6–36
setup 9–10
DATE
advanced 6–38
Dead zones A–5
equatorial 3–2
geometry 3–1
parallel alignment 3–2
polar 3–2
right angle alignement 3–2
Deep discharge 2–7, 10–3
Delay
RS-232 output 6–35
Desiccant
cartridge 6–3
exchange 10–6
Determining
operating zones 3–3
Disassembly
console 10–8
Display
Auxiliary 6–33
Configuration
advanced mode 6–20
Data collection
advanced mode 6–26
Basic mode 6–16
search mode 6–19
data output 6–34

data recall (graphic)
advanced 6–30
general layout 6–12
graphic
scaling 6–32
graphic mode
advanced 6–28
heater 6–22
Help
screens 6–11
INFO 6–6, 6–38
Information 7–21
instrument setup 6–22
Intensity control 7–25
LED
installing 2–5
mag setup 6–23, 7–16
main 7–5
Main operating
advanced mode 6–20
Note entry 6–6
NOTES 6–37
numeric data
advanced mode 6–26
pages 6–10
parameters
Advanced 6–20
Basic mode 6–13
Search mode 6–18
pop-up windows 6–10
prompt line 6–8
Recall 6–6
recall
advanced mode 6–29
sub-panels
accessing 7–5
title line 6–8
Display intensity control 7–25
Display screens 6–8—6–12
Search mode 6–17
Displaying
total field value
SM–4 4–5
SM–4G 5–6
Displays
Configuration
basic mode 6–12
Distance trigger 6–39
Diurnal corrections
Tie-point mode 8–18
DIVBY
advanced 6–21
basic 6–15
formula 6–39
Drum Location 6–12
Dumping data 9–12
All Data 9–12
BINARY dump 9–13
Line by Line 9–14
Specific data 9–13

E

Effects of gradient 8–2
ENTER key 6–5, 6–32
Enter! 7–6
EPROM 7–27
Equatorial dead zone 3–2
ERASE MEMORY
advanced 6–22
basic 6–14
Erasing data memory 9–15
ESCAPE key 6–5
External
power connector 6–3
power supply 2–10
External battery pack 2–8

F

FIELd function
SM–4 4–7
SM–4G 5–8
First time operation 7–1

FLASH function
SM–4 4–7
SM–4G 5–7
Flash memory
programming
SM–4 4–7
SM–4G 5–7
Format
data output 6–35, 6–36
Free memory 6–38
Functions
SM–4
Audio 4–6
blank display 4–5
FIELd 4–7
FLASH 4–7
LoPAS 4–6
north 4–6
rAtE 4–7
SM–4G
Audio 5–7
blank display 5–6
FIELd 5–8
FLASH 5–7
LoPAS 5–7
north 5–6
rAtE 5–8
Fuse 6–3
Fuse Replacement 10–7

G

Geometry
dead zones 3–1
GRAD
slave processor 5–3
Gradient 6–27, 6–28
effects of 8–2
Gradiometer
assembling
horizontal 5–10
vertical 5–9
connecting cables 5–3
kit 5–9
Graphic Data Display 6–28

H

Heading errors A–5
Headphones
PITCH parameter
SM–4 4–4
SM–4G 5–4
setting audio sensitivity
SM–4 4–6
SM–4G 5–7
using with
SM–4 4–4
SM–4G 5–4
HEATER
advanced 6–22
Heater
display 6–22
Help screens 6–11
HELP-Line xvii
HEM
advanced 6–25
basic 6–18
Hemisphere
advanced mode function 6–25
basic mode function 6–14
search mode function 6–18
Hemisphere setting
SM–4 4–6
SM–4G 5–6
Herring-bone pattern 8–5
Horizontal Gradiometer
assembling 5–10

I

INFO 6–38
INFO key 6–6
Information display 6–6, 6–38, 7–21

Input
alphanumeric 6–7, 7–6
numeric 7–6
Installation
audio option kit 2–6
battery belt 2–3
console battery 2–7
LED display 2–5
shoulder strap 2–6
Instrument
auto turn-off 6–9
overview 1–3
Instrument setup
Advanced mode example 7–14

K

Key
AUX/LCD 6–5, 6–33
CLEAR 7–6
cursor 6–5
ENTER 6–5, 6–32
ESCAPE 6–5
INFO 6–6
advanced 6–38
minus (–) 6–7
NEXT 6–6, 6–10
NOTE 6–6
NUM/GRA 6–6
ON/OFF 6–5
plus (+) 6–7
RECALL 6–6
RECORD 6–6
TIE-PT 6–6
Key functions 6–5
Keypad 6–3
SM–4 4–5
SM–4G 5–6
SMARTMAG console description 6–4

L

Larmor frequency A–1
LCD 6–3
heater 6–22
intensity 6–5
LED display
installing 2–5
update rate
SM–4 4–7
SM–4G 5–8
Line
entering start 7–8
number 6–15, 6–21
separation 6–15, 6–21
setup 7–7
Tie-point data collection 8–16
Lines
repeated 8–3
Liquid Crystal Display 6–3
LN
advanced 6–21
basic 6–15
Local field strength
setting
SM–4 4–7
SM–4G 5–8
LOCAL FLD.
advanced 6–23
Locking parameters 6–33
Loop
Tie-point data collection 8–15
LoPAS
function
SM–4 4–6
SM–4G 5–7

M

Macros 6–37, 7–23
MAG
advanced 6–20

MAG SETUP
advanced 6–22
MAG SETUP display 7–16
Magnetic gradient 6–27, 6–28
Magnetometer setup display 6–23
Main operating display 6–20, 7–5
Maintenance
general rules 10–1
periodic 10–6
Manual mode
survey 8–7
Master processor SM–4G 5–2
Memory
erasing 9–15
percent free 6–27, 6–38
Menu
SMARTMAG Configuration 7–3
Minus key (–) 6–7
MODE
advanced 6–23
basic 6–13
search 6–18
Modes
Tie-point 8–15
WALKMAG 8–4

N

NEXT key 6–6, 6–10
NOISE 6–27
Noise
sources of 8–2
north function
SM–4 4–6
SM–4G 5–6
Note entry
display 6–6
NOTE key 6–6
NOTES 6–36, 9–6
display 6–37
entry 7–23
NUM/GRA key 6–6
Numeric Data Display 6–26
Numeric input 7–6

O

ON/OFF key 6–5
Operating displays 6–12—6–38
Operating modes
advanced 6–1
basic 6–1
pre-defined 6–1
search 6–1
Operating system
reprogramming 7–27
Operating zones
determining 3–3
OPERATOR 6–38
Operator
preparation 3–1
Orientation 8–2
Orienting
SMARTMAG A–1
OUTPUT
basic mode 6–14
Output
formats 9–1
Setup 9–10
Output format
BINARY 9–7
NOTES 6–36, 9–6
PRN 6–36, 9–5
XYZ 6–36, 9–2
XYZ+ 6–36, 9–3
XYZ++ 6–36, 9–4
Output procedures
Advanced mode 9–10
Basic mode 9–9
Overview
instrument 1–3

P

packaging 2–2
Page (display screens) 6–10
Panning (graphic display) 6–30
Parameter fields
    accessing 7–5
Parameters
    Advanced mode 6–20
    basic mode 6–13
    changing 7–5
    locking 6–33, 7–26
    search mode 6–18
    separation 7–8
    setting
        SM–4 4–4
        SM–4G 5–5
    unlocking 7–26
Performing a survey
    SM–4 4–8
    SM–4G 5–10
Periodic maintenance 10–6
PITCH
    advanced 6–25
    basic 6–13
    search 6–18
PITCH parameter
    headphone sensitivity
        SM–4 4–4
        SM–4G 5–4
Plus key (+) 6–7
Polar dead zones 3–2
Polarity 2–10
Pop-up windows 6–10
Power supply
    AC 2–10
    external 2–10
Preparing
    operator for survey 3–1
    SMARTMAG 2–1
PRN 6–36, 9–5
Processor
    master (SM–4G) 5–2
    slave (SM–4G) 5–3
Programming
    flash memory
        SM–4 4–7
        SM–4G 5–7
Prompt line 6–8, 7–6

R

RATE (sample rate) 6–23
rAtE function
    SM–4 4–7
    SM–4G 5–8
Recall
    Data Display 6–30
    display 6–6, 6–29
    Setup display 6–29
RECALL key 6–6
RECORD key 6–6
Repacking 2–2
Repair
    cable 10–9
Repairs 11–5
    shipping instructions 11–6
Repeated surveys lines 8–3
Reprogramming
    operating system 7–27
RS-232 output delay 6–35

S

Sample Note entry 7–23
Sample setup
    base-station 7–18
    Basic mode (total-field) 7–9
    Information display 7–21
    Search mode 7–12
    WALKGRAD survey 7–15
    WALKMAG survey 7–15
Sample survey
    manual mode 8–7
    search mode 8–12

WALKMAG 8–4
gradiometer 8–6
Scale
graphic display 6–32
Search mode 6–1, 7–12, 8–12
Advanced mode setup 8–13
Basic setup 8–12
data collection displays 6–19
parameters 6–18
sample setup 7–12
sample survey 8–12
Select! 7–6
Sensor
adjusting head angle 3–4
connectors 6–3
orientation recommendations A–14
orienting A–1
parallel alignment dead zones 3–2
right angle alignement dead zone 3–2
troubleshooting guide 10–10
Sensor assembly
connecting to battery belt 2–4
SEP
advanced 6–21
basic 6–15
Separation
line 6–15, 6–21
parameters 7–8
station 6–15, 6–21
Serial number 6–38
Setting
bandwidth
SM–4 4–6
SM–4G 5–7
headphone audio sensitivity
SM–4 4–6
SM–4G 5–7
hemisphere
SM–4 4–6
SM–4G 5–6
local field strength
SM–4 4–7
SM–4G 5–8
parameters
SM–4 4–4
SM–4G 5–5
Setup
base-station 7–18
data output 9–10
general principles 7–4
line 7–7
mag setup display 6–23
SMARTMAG 7–14
station 7–7
Shipping 2–2
instructions 11–6
Shoulder strap
installing 2–6
Slave processor SM–4G 5–3
SM–4
assembling 4–2
bandwidth setting 4–6
components 4–2
displaying total field value 4–5
flash memory programming 4–7
functions
Audio 4–6
blank display 4–5
FIELd 4–7
FLASH 4–7
LoPAS 4–6
north 4–6
rAtE 4–7
headphones
setting audio sensitivity 4–6
usage 4–4
hemisphere setting 4–6
keypad 4–5
LED display update rate 4–7
parameters 4–4
performing a survey 4–8
PITCH
headphone sensitivity 4–4
setting

local field strength 4–7
turning on 4–3
SM–4G
assembling 5–2
horizontal gradiometer 5–10
vertical gradiometer 5–9
bandwidth setting 5–7
components 5–2
connecting cables 5–3
displaying total field value 5–6
flash memory programming 5–7
functions
Audio 5–7
blank display 5–6
FIELd 5–8
FLASH 5–7
LoPAS 5–7
north 5–6
rAtE 5–8
headphones
setting audio sensitivity 5–7
usage 5–4
hemisphere setting 5–6
keypad 5–6
LED display update rate 5–8
master processor 5–2
parameters 5–5
performing a survey 5–10
PITCH
headphone sensitivity 5–4
setting
local field strength 5–8
slave processor 5–3
turning on 5–4
SMARTMAG
active zone A–2
configuration menus 7–3
console
key functions 6–5
console keypad description 6–4
dead zones A–5
distance trigger 6–39
heading errors A–5
Instrument Setup Display 6–22
operating with console 8–1
orienting sensor A–1
preparing 2–1
repairs 11–5
sensor orientation recommendations A–14
Setup 7–14
software version number 6–38
Technical Specifications 11–1
warranty 11–5
Software
SMARTMAG version number 6–38
ST
advanced 6–20
basic 6–15
Starting line
entering 7–8
Starting station
entering 7–8
Station
auto increment 6–22
entering start 7–8
increment
manual 7–15
number 6–20
separation 6–15, 6–21
setup 7–7
Survey
correction procedures 8–14
Survey lines
repeated 8–3
Symbols xvi

T

Technical specifications 11–1
Technical support xvii
Text entry 7–23
TIE
basic 6–14

TIE CORRECT
advanced 6–24
TIE MODE
advanced 6–25
Tie-Line
correction 6–24
Tie-point 8–16
correction 6–6, 8–19
correction procedures 8–18
Line mode data collection 8–16
Loop correction procedure 8–18
Loop mode data collection 8–15
mode 8–15
TIE-PT key 6–6
TIME 6–27
advanced 6–38
Title line 6–8
TM/DT
basic 6–13
TOTAL
master processor 5–2
Total field values
displaying
SM–4 4–5
SM–4G 5–6
Troubleshooting
console 10–11
sensor 10–10
Tumble angle A–2
calculation A–5
TUNE FIELD
basic 6–13
search 6–18
Tuning
automatic 7–15
Turning on
SM–4 4–3
SM–4G 5–4
Type styles xv
Typeface
conventions xv

U

Unlocking parameters 7–26
Unpacking 2–2
Update rate
LED display for
SM–4 4–7
SM–4G 5–8

V

Vertical Gradiometer
assembling 5–9

W

WALKGRAD
sample survey setup 7–15
WALKMAG xi
Gradiometer Survey 8–6
Sample survey
setup 7–15
sample survey 8–4
Warranty 11–5

X

XFSMART
converting binary data 9–7
XYZ 6–36, 9–2
XYZ+ 6–36, 9–3
XYZ++ 6–36, 9–4